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EDITORIAL

Corrosion of Light Metals

DURING the past year the Society has been fortunate in having heard two notable contributions to the literature of metal corrosion. In March we published Dr. Bengough's paper on the Corrosion of Metals in Salt Solutions and Seawater, and in this week's issue of the JOURNAL there appears Mr. Freeman Horn's excellent paper dealing with Corrosion Research on Light Metals. One does not need to be a metallurgist to appreciate the interest of this article, for corrosion has always been a problem in most of our industries, and although data concerning its causes and prevention continue to accumulate we are as yet some way from being able to claim mastery over the conduct of metals when exposed to corroding influences. It might indeed be said that the problems of corrosion, as far as light metals are concerned, have only become of great importance during the last few years. A quarter of a century ago there was no great urgency to study the corrosion of aluminium, but to-day we have an aircraft industry in which attention must be given above all else to the reliability of materials employed, whilst aluminium has come to be used in many other industries. Still more recently has magnesium come to be considered of likely importance for structural work. Of the other light metals, it appears that much attention is being given in Germany to the possibility of employing lithium in light alloys; the importance of silicon alloys needs no emphasis here, and the metallurgist will no doubt find useful applications of beryllium. The [illegible] need for research on the corrosion of all the light metals can be readily appreciated. There may perhaps be some who, not having given much thought to the subject, may wonder [illegible] this subject of corrosion is receiving so much atten[illegible] nowadays, feeling perhaps no great desire for [illegible]nd span untarnishing world. The well-[illegible]ered surface, they may say, is often more pleasing than an aggressively new one. This aspect of corrosion has n[illegible] been lost sight of; we can instance the fact that Dr. [illegible] J. Vernon has this year described a process for the artificial production of the green patina on copper sheets. But this aspect of corrosion is of relative insignificance, and much more important is the fact that pitting and intercrystalline corrosion may cause losses of tensile strength out of all proportion to the actual loss of material. Corrosion in fact may be a sort of catalyst in the process of destruction. Mr. Horn also points out that the rate of corrosion of the light metals is small compared with the more familiar rusting of ferrous metals. But these comparatively small modifications of the light metals may have far-reaching effects, as is seen when the subject of corrosion-fatigue is considered. Those who were privileged to visit the National Physical Laboratory recently will have an idea of the work which is being pursued on this side of the subject. This is only one centre in which corrosion is being studied, and it is inevitable that with the variety of circumstances and conditions obtaining in different situations a vast amount of information should have become available which cannot always be correlated with a single theory. It is good to learn however that two facts now appear "like lighthouses in a sea of conflicting theories," namely, that corrosion of metals is essentially an electrochemical phenomenon, and that whatever resistance to corrosion is exhibited by any metal is due to the presence of a microscopically, or even sub-microscopically, thin film of oxide which forms on exposure to air or other gas containing measurable quantities of oxygen. In this nothing new is propounded, but an assertion is made with some confidence where there has before often been only tentative suggestion. If Mr. Horn needs any corroboration of the electrochemical significance of corrosion, he gets it this week in the announcement that the Electrochemical Society of America intends to hold in September next an international convocation on this troubled subject of corrosion. At this convocation many famous American and European metallurgists will compare notes, and although nothing strikingly new may emerge, we may expect the many phenomena associated with corrosion to be still further disciplined into an orderly body capable of moving forward.

CORROSION RESEARCH ON LIGHT METALS*

By FREEMAN HORN

Introductory.—The subject of the present paper is not corrosion of light metals, but corrosion research on light metals. There is an important difference, as many light metals, including pure aluminium, are non-corrosive under ordinary atmospheric conditions and even highly resistant to many acids and other compounds which rapidly attack iron, copper, and most of the other metals.

Certain of the light metals and alloys, particularly those with a magnesium base, are subject to varying degrees of corrosion under certain conditions, such as salt spray, and increased attention is now being paid to research into the underlying causes of corrosion and the best or most economical methods of its prevention under varying operating conditions. It is within my memory when to mention corrosion in connexion with aluminium was to risk dismissal, but it is now realized that all metals will exhibit corrosion under certain conditions, and that even aluminium, or at any rate the high-duty alloys of aluminium such as duralumin, show appreciable corrosion under, for instance, sea-water conditions, unless means are taken to protect them. There are, so to speak, two sides to corrosion, the chemical side and the mechanical side, and it is the latter aspect of the subject with which I propose to deal mainly in this paper, first because there are others better fitted to deal with the chemical side, and, secondly, because, as an engineer, I am less interested in the chemical and electrochemical reactions which take place between the metal and the corroding agent than in the effects of such corrosion upon the physical and mechanical properties of the metal, particularly when used as a material for construction, of, for instance, aircraft.

Light metals.—There are five metallic elements which can be classed as light metals, namely, aluminium, magnesium, silicon, beryllium, and lithium, having specific gravities of 2·7, 1·8, 2·0, 1·8, and 0·53 respectively. Of these, the first two are the only ones which have so far been made the bases of industrial alloys. Silicon is not obtainable alone in the metallic state, but is added to aluminium up to 25% to produce a series of extremely useful alloys. Beryllium has so far not been obtained in a sufficient state of purity to determine accurately its true physical and mechanical properties, while no useful alloys of beryllium with aluminium have so far been discovered, though the remarkable properties which quite small percentages impart to copper give some hope for the future, and serve as an incentive to research. So far all attempts to get beryllium to alloy with magnesium have failed utterly, present indications being that beryllium is completely insoluble in magnesium up to the volatilization temperature of the latter metal under normal pressures.

Recently it has been reported that experiments which are claimed to open up revolutionary possibilities are taking place in Germany on light alloys contai[ning] lithium, but so far details are lacking. Patents [have] also been taken out in Germany for alloys contai[ning] lithium, which are claimed to be highly resistan[t to] corrosion, but I have so far seen no reliable test d[ata] either mechanical or chemical, upon such all[oys]. Certainly the very low specific gravity of lithium m[akes] the prospects of such alloys very attractive and fur[ther] developments are awaited with interest. Lith[ium] apparently alloys readily with beryllium, giving fa[irly] stable alloys with specific gravities in the neighbourh[ood] of 1, but no information is at present available on [the] properties of these alloys or the possibilities of produ[cing] ternary alloys with aluminium which will have indus[trial] possibilities.

The three light metals with which we are, theref[ore,] at present mainly concerned are aluminium, magnesi[um] and silicon, of which the first two alone form the b[asis] of useful alloys; both are, however, in the pure s[tate] insufficiently strong for structural purposes whe[re a] high strength/weight ratio is required. Aluminiu[m is] by far the most important, largely on account o[f its] film-forming properties and consequent high resista[nce] to corrosion. The metals with which it is chi[efly] alloyed are copper, silicon, zinc, magnesium, mangan[ese] and nickel in the approximate order of their importa[nce]. Magnesium is alloyed mainly with aluminium or m[an]ganese, with small additions of other metals to ob[tain] special properties. The resistance to corrosion of t[he] various metals and alloys varies within wide limits, [the] pure metal being, in general, more resistant than all[oys]. As pure aluminium is highly resistant to atmosph[eric] corrosion, it is with its alloys that we shall have mai[nly] to deal.

Corrosion theories.—Out of the mass of theories [and] counter-theories, the engineer is able to grasp w[hat] appear to be two fundamental truths, namely t[hat] corrosion of metals is essentially an electrochem[ical] phenomenon and that whatever resistance to corros[ion] is exhibited by any metal, even pure iron, is due [to] the presence of a microscopically, or even sub-mic[ro]scopically thin and usually transparent film of ox[ide] which forms, in some cases instantaneously, on [the] surface of the metal when exposed to air or other [gas] containing measurable quantities of oxygen. Th[ese] two facts appear to me like lighthouses in a sea of c[on]flicting theories, as they are apparently able to expl[ain] sufficiently most of the otherwise inexplicable phe[no]mena of corrosion. According to the first theo[ry] corrosion is always caused by differences of electr[ic] potential, or what chemists call differences of solubi[lity] pressure inside the corrosive medium either betw[een] the metal or alloy affected and some outside meta[llic] body or between different constituents of the sa[me] alloy or even between different parts of the same me[tal]. If this theory be correct, it follows that a chemic[ally] pure metal of uniform physical condition totally immer[sed] in a chemically pure uniform simple solution will [not] corrode, and there appears to be increasing evidence [to] show that this is indeed the case. When, however, i[t is] remembered that differences of potential can e[xist] between different parts of a piece of pure metal du[e]

* Read before the Chemical Engineering Group on January 13, 1933.

differences of internal stress set up in cooling from the molten state, from mechanical working, from heat treatment and even from the means used to support the sample in the test tube, not to mention the difficulty of obtaining atomically pure materials, it will be realized how difficult it is to prove the truth of this theory.

Since according to the second theory, resistance to corrosion is merely some form of oxidation, and is due to the presence of a film of insoluble oxide on the surface, then immunity to corrosion will depend upon the thickness and impermeability of the oxide film formed under the given conditions, and its adherence to the surface and its insolubility in the corrosive liquid. In practice, the mechanical strength and resistance to abrasion of the film also play important parts, and this is particularly so with aluminium which is a relatively soft metal but whose normally formed oxide is extremely hard. Another factor of importance is the rapidity with which the film forms when damaged by chemical or mechanical means and here again the practically instantaneous formation of the oxide film on aluminium is of vital importance. The resistance of aluminium to corrosion by ordinary and salt bearing atmospheres is in contrast to its chemical reactivity, which is high, as evidenced by the instantaneous formation of an oxide film. It is only when aluminium is subject to alkaline conditions which dissolve the oxide and attack the underlying metal that serious corrosion takes place or when local elements are set up which prevent the formation of less stable, less adherent, or less insoluble forms of oxide or hydroxide.

Classes of corrosion.—Corrosion may be divided roughly into three main classes, namely general corrosion in which the whole surface of the metal is attacked more or less uniformly; pitting, in which the attack is concentrated at particular spots; and so-called intercrystalline corrosion, where the attack proceeds, frequently almost unobserved from the surface, downwards into the heart of the metal between the individual crystals. This at any rate was the theory held until recently to account for what is known as corrosion embrittlement, but the more recent research appears to indicate that the corrosion does not necessarily take place at the crystal boundaries but may occur at the slip planes of the crystals themselves.

Aluminium and the simpler alloys of aluminium with metals which form homogeneous stable intermetallic solutions are remarkably free from any of these forms of corrosion under most atmospheric conditions, due, as has been shown above, to the tenacious and insoluble film of oxide and to the fact that no intermetallic differences of potential exist. Alloys of aluminium, however, which depend upon the presence of one or more intermetallic compounds insoluble, or partly insoluble, in the base metal, or still more to the precipitation in the solid state of such intermetallic compounds, usually in a fine state of sub-division, are more likely to be subject to corrosive influences by reason of differences of potential set up between the base metal and such intermetallic compounds. Although metallurgists talk quite glibly of these various changes and reactions which occur within alloys, both in the liquid state, during solidification and subsequently in the solid state, both at low and high temperatures, this branch of the science of metallurgy has not yet reached the stage when the behaviour of any given mixture of metals can with certainty be foreseen, or how the various elements will arrange themselves under any given conditions of mixing, melting, solidifying, or subsequent treatment in the solid state. Neither is it yet possible to predict with any certainty how any given alloy will behave under corrosive influences; at present general conclusions only can be drawn, based upon research data rather than purely theoretical considerations, and a vast amount of such research data is now steadily accumulating upon which it may one day be possible to build up exact metallurgical theories and formulæ from which the properties and behaviour of any particular mixture of metals, produced under certain specified conditions, can be predicted. At present we are, however, far from that ideal and we must rely, in the main, for our information on the relation between corrosion and mechanical properties of metals upon experimental data.

Corrosion Research

Many methods of measuring relative resistance of metals and alloys to corrosion have been employed by different workers, and have depended to some extent upon the corrosive influences whose effect it is desired to determine and the properties of the metal upon which it is desired to show the effect of corrosion. The engineer desires primarily to determine the effect of corrosion upon the mechanical properties; in other words, the effective loss of strength which determines the useful life of the structure, or the extra thickness of metal required to allow for the effect of corrosion for any specified life. There is obviously no object in designing parts of a vehicle to last for 50 years under normal operating conditions if the engine will be worn out in 10 years or the whole vehicle scrapped as out of date in perhaps half that time.

Apart from chemical plant, the only use of aluminium and aluminium alloys in which corrosion plays an important part is the aircraft industry, where conditions dictate the use of special high-duty, heat-treated alloys, with the highest ratio of strength to weight possible, irrespective of corrosion resistance, but where, paradoxically, a very high resistance to corrosion is essential owing to the low factors of safety employed and to the comparatively thin sections involved where any loss of thickness becomes relatively serious. As a result most of the corrosion research on light metals has been carried out on aircraft materials simulating the corrosive influences met with under aircraft operating conditions. These conditions may be put into three main classes, as follows:

(1) ordinary atmospheric conditions, which include more dry than wet and more sun than rain, except where aircraft remain in the open all night and collect dew, which is worse than rain:

(2) fresh water submersion or half-submersion, including fairly rapid alternating wet and dry:

(3) salt water submersion or half-submersion, which also includes wet and dry—mostly wet, because the salt remaining from the evaporated sea water gradually accumulates and, being hygroscopic, collects moisture on the least provocation.

It has, however, been found, as far as aluminium alloys are concerned, that relative corrodibility under fresh water and salt water wet and dry conditions is, in general, of the same order, and it is usual to determine the corrosion resistance by some form of accelerated salt water test, supplemented and confirmed where possible by long-time field or ocean tests.

Unfortunately a fairly wide variety of such accelerated corrosion test methods has been employed by different workers, with the consequence that the results are seldom comparable and a great part of the value of the researches is lost. The chief European aluminium producers some years ago formed an International Propaganda Bureau to study all matters bearing on the development of new uses for aluminium and its alloys, and one of the useful works performed by the Bureau has been the correlating of the different corrosion testing methods employed in the laboratories of the various producing companies and research institutions, and the drawing up of a standard corrosion test procedure to be followed by all the aluminium producers, which was recently issued in the form of a memorandum.

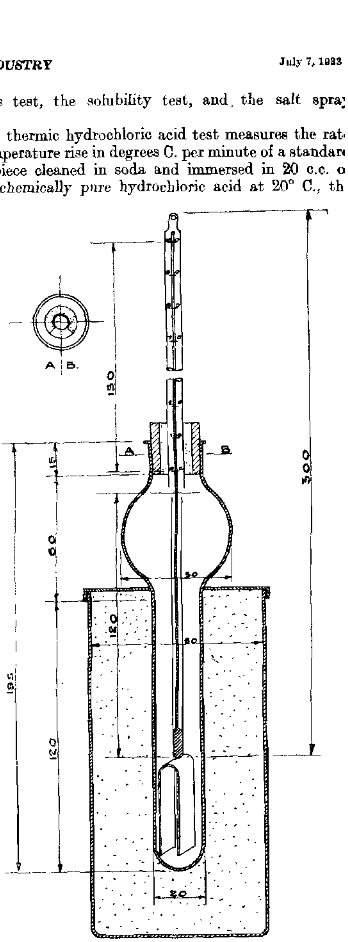
This memorandum deals first with general considerations regarding methods of expressing composition of alloy, mechanical and thermal treatment to which it has been subjected and the nature and condition of the surface. It next recommends certain standard sizes of test pieces for cast and wrought material respectively and suggests the most suitable sizes of beakers, methods of cleaning and other practical details in carrying out corrosion tests. It advocates that all tests should be carried out at room temperature and that the test piece should be suspended in the liquid by means of two holes, top and bottom, to allow it to be inverted once a week.

It is recommended that test pieces should be cleaned by one of the following methods. Cleaning with soda should only be used for the thermal hydrochloric acid test, or for such others in which the protective value of the surface skin formed in the process of manufacture is to be deliberately ignored. Degreasing in petrol, followed by absolute alcohol and finally rinsing in distilled water, is recommended for all standard conditions.

The memorandum then proceeds to deal with five commonly used methods of testing corrosion, laying down recommendations regarding the exact procedure to be followed in each case in order to secure, as far as possible, uniformity of results.

These test methods are divided into two main groups designated respectively rapid tests and corrosion tests proper, the former being super-accelerated and suitable for rough comparisons only. The former contains the thermic hydrochloric acid test, due to Mylius, the volumetric hydrochloric acid test, and the Mylius activated corrosion test, while the latter covers the modified Mylius test, the solubility test, and the salt spra[y] test.

The thermic hydrochloric acid test measures the rat[e] of temperature rise in degrees C. per minute of a standar[d] test piece cleaned in soda and immersed in 20 c.c. o[f] 10% chemically pure hydrochloric acid at 20° C., th[e]



DIMENSIONS IN MILLI-METRES

FIG. 1

Thermic hydrochloric acid test

average increase being known as the Mylius figure named after the inventor of the process, who, a few year[s] ago, published a vast amount of data bearing on thi[s] subject in Germany; the test requires extreme care an[d] accuracy if anything like concordant results are to b[e] obtained.

For metals in which the corrosion is insufficien[t] to cause a measurable rise in temperature, the ga

ımetric test may be used. In this the time taken for c.c. of hydrogen to be evolved when the test piece reated with a 5% solution of hydrochloric acid is ısured under the same conditions as in the previous . the result being usually expressed in c.c. of hydrogen hr. per sq. cm. of metal. This test also requires

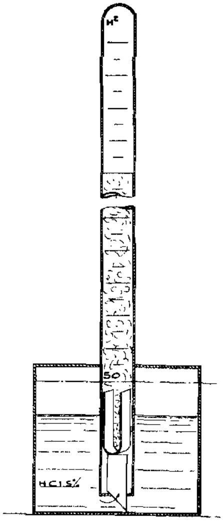


FIG. 2

Volumetric gas test

at care, and necessitates allowances for differences in ometric pressure etc. and can hardly, therefore, be led a routine test.

The Mylius activated corrosion test measures the s of weight of a standard sample after 24 hrs.' immern in a 1% sodium chloride solution activated by 3% hydrogen peroxide, the products of corrosion being noved by means of hot concentrated nitric acid, ich dissolves the aluminium oxide but leaves the tal intact.

In all these rapid tests the measure of corrosion is rely empirical, and none takes account of the type corrosion or its effect upon any of the properties the material with which the user is mainly concerned. is, however, has been corrected in the accelerated rosion tests proper which follow.

In the first of these, the modified Mylius test, a set of standard tensile test pieces is subjected to the ... of a 3% solution of sodium chloride kept at a ... nt activated concentration of 0·1% of hydrogen ... ide and the samples removed in turn at regular ervals of ½, 1, 2, or 3 months, according to the p...ent rate of corrosion. They are then subjected to mechanical tests to determine breaking stress and elongation, the percentage loss compared with uncorroded control specimens being plotted against time to show the relative progress of loss of mechanical properties through corrosion.

In the salt spray test a set of standard test pieces is similarly subjected to the corrosive action of a spray of 3% solution of salt water, created by an atomiser in such a way that no liquid reaches the plates, which are solely in contact with saline vapour. The test pieces are again removed in series at intervals of ½ to 6 months, the measure of corrosion being taken as the rate of loss of tensile strength and elongation. It is suggested for both these tests that the corrosion test sample shall

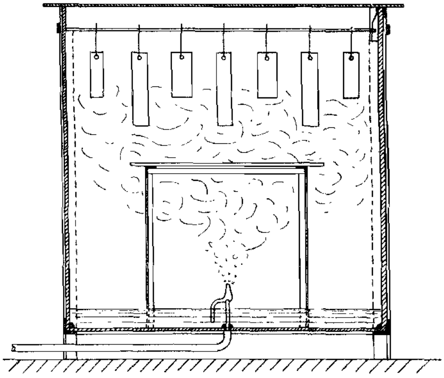


FIG. 3

Salt spray test

be wider than the standard tensile test sample to enable a few millimetres to be skimmed off each edge in order to eliminate errors due to rough edges acting as notches, and thereby giving too low a tensile test reading. Neither of these tests requires any elaborate apparatus or more than ordinary care in its carrying out, but both are capable of producing reliable and concordant results, which are, moreover, given in units capable of direct application to the problems of design.

Finally, there is the alternate immersion test, in which samples are alternately immersed and withdrawn from a standard salt solution at fixed intervals of time, usually either every 15 mins. (short period, operated by clockwork) or every 12 hrs. (long period, done by hand). The measure of corrosion is usually either the percentage loss of weight or percentage loss of tensile strength at the end of a fixed time, but so far the units in which the results are to be expressed or the strength of the different solutions have not been fixed.

The only tests of mechanical properties put forward are those for breaking load and elongation, but for many purposes bending and cupping tests would give more useful results, and such tests are provided for in

the German D.V.L., Aircraft Research Bureau, standard laboratory tests.

None of these accelerated corrosion tests can give results as useful as field tests which subject the material to conditions analogous to those met with in practice, but, unfortunately, such tests take years, where short-time tests take days, weeks or, at the worst, months. What is now needed is reliable data which will correlate the results of these short-time tests with the actual conditions in each particular class of service, so that it would only be necessary to multiply the time taken in hours to lose say 10% of strength under a particular test by a factor to obtain the useful life in years under any particular service conditions. We are, however, still a long way off that and there is, therefore, still plenty of scope for further research. As the standard corrosion tests were based upon parallel sets of experiments carried out independently in the laboratories of all the European aluminium producers, perhaps similar co-ordination plus co-operation with outside bodies better able to conduct field tests may one day result in a standardized correlation between laboratory and field tests.

Effects of corrosion.—The effects of corrosion, from the engineer's point of view, may be again roughly divided into three main groups, according to the nature of the corrosion:

(1) Uniform corrosion over the whole surface of the metal which results in a loss of tensile strength more or less in proportion to the loss of thickness or section and very little loss of elongation or its counterpart increased brittleness. This is the least serious of all forms of corrosion, first, because, for any total amount of corrosion the loss of strength is a minimum by reason of its fairly equal distribution over the whole surface, secondly, because it is visible and its amount and seriousness easily computed and either allowed for or the part replaced when necessary, and, lastly, because a uniform corrosion acts to some extent as a protection to the underlying metal and no local elements between the metal and accumulations of corrosion products are likely to be set up.

(2) Pitting or local corrosion is due mainly to differences of potential between the base metal and segregations of richer or poorer phases, or between different groups of phases, or external stresses. It results in a loss of tensile strength and elongation frequently out of all proportion to the loss of material through corrosion, and the more localized the corrosion, that is, the deeper the pits, the greater obviously will be the disproportion between loss of strength and loss of metal. Added to this, there is often a marked acceleration in the rate of corrosion as the depth of pit increases due to local elements set up by the retained and concentrated products of corrosion and to the pit retaining moisture and perhaps never quite drying out between wetting periods.

(3) Intercrystalline corrosion is a form of corrosion the true extent and significance of which has only recently begun to be realized, but it is the most dangerous of all and the most difficult to combat, as there is frequently little evidence of it on the surface. It causes a loss of both tensile strength and elongation out of all proportion to either the visible or invisible loss of material and, in addition, may cause a serious loss of fatigue strength, *i.e.*, it reduces the maximum alternating stress which the part will indefinitely withstand, or reduces the number of such reversals of stress of any given magnitude which the part will withstand before fracture occurs.

Composition of metal.—The most important factor affecting corrosion is the composition of the metal or alloy and its degree of purity, and a vast amount of research work has been carried out to determine the influence of both metallic and non-metallic impurities and of every conceivable alloying element on the corrosion resistance of both aluminium and magnesium alloys.

What was probably the first systematic research into the relative corrosion of aluminium alloys was undertaken by the late Professor Wilson of King's College, who at regular intervals over a number of years determined the electrical conductivities, the corrosion products and tensile properties of a number of light alloy wires suspended on the roof of King's College and subjected to the all-the-year-round action of London atmosphere. Straight alloys with copper, nickel, and magnesium were mainly used, such as are now no longer employed for modern high-duty work and the results accordingly are of more or less academic interest only.

Since that time systematic research into the influence of composition on the resistance to corrosion of light alloys has been pursued in all countries, the outstanding feature of most of which appears to be that of the straight binary alloys; those containing some 12% of silicon, (eutectic composition) and those with up to 2% of manganese are, under ordinary conditions, the most resistant to corrosion, the former being suitable for castings and the latter for sheet. Neither of these simple alloys, however, gives the very high mechanical properties demanded by modern aircraft designers and it usually becomes necessary to employ a ternary or still more complicated alloy in which some special attribute is obtained by the addition of each alloying element, resistance to corrosion being up till recently not unnaturally the last factor to be considered. More recently, however, the influence of small additions of other metals, including rare metals, on the resistance to corrosion of these high duty alloys has been systematically studied, largely behind closed doors in the laboratories of the various firms specializing in these products. So far no alloy has to my knowledge made its appearance which in the wrought and finished condition combines the high strength and ductility of duralumin with a still higher corrosion resistance than that possessed by that metal, which contains about 4% of copper and 0·5% each of magnesium and manganese.

In case this reiteration of corrosion in connexion with aluminium alloys should give rise to misapprehension and misgivings, it may be as well to point out that the rates of corrosion with which we are here dealing are normally almost negligible compared, for instance, with the rusting of ferrous metals, and that the high corrosion resistance of the so-called aluminium bronze, an alloy of copper with about 10% of aluminium, and of aluminium brass, an alloy of copper with zinc, and

% of aluminium added, are due entirely to the film-forming properties of the aluminium which they contain.

Corrosion of duralumin.—Duralumin being still the standard light alloy used in the construction of aircraft, most of the work on the phenomena of corrosion has been carried out on this material, and I will attempt a short review of the more important researches carried out to date. Fully to appreciate the problems involved, it is necessary to understand the methods by which duralumin acquires its remarkable properties, as variations in these methods have in certain circumstances a marked effect upon its resistance to corrosion, which is normally high but not sufficiently high for the very severe and exceptional conditions met with in aircraft, particularly in seaplanes.

Duralumin owes its high tensile strength and ductility to a form of heat-treatment known as age-hardening, this being in reality only the final stage in the process. The Germans have the words Vergüten or Veredeln, to improve or ennoble, to describe the whole process of heating, quenching, and ageing, but unfortunately there is no such word in English and we have to fall back upon age-hardening, precipitation heat-treatment, or simply heat-treatment which covers almost anything. As most theories of corrosion embrittlement depend upon the so-called precipitation theory of hardening first enunciated by Dr. Gayler of the National Physical Laboratory, it will be explained shortly.

Both solid and liquid metals behave much the same as aqueous solutions, they are capable of dissolving other metals up to a certain saturation point, which differs with different metals and varies with the temperature and other factors. For copper in aluminium the solid solubility rises from about 0·5% at room temperature to nearly 5% at something over 500° C., and if such an alloy, containing say 4% of copper, is heated to above 500° C. and maintained at that temperature sufficiently long, the whole of the copper will go into solid solution, and remain as long as the temperature is kept above 500° C. If, however, it is allowed to cool slowly, the copper will again slowly come out of solution and we shall be as we were with about 0·5% in solution at room temperature, the remainder being in the form of the normal eutectic compound $CuAl_2$. If, on the other hand, the alloy is quenched rapidly from 500° C., the copper has not time to come out of solution and a rather unstable supersaturated solution of copper in aluminium results. The copper is kept a prisoner in the aluminium against its will because the door was closed too rapidly for it to escape. The lower the temperature at which the supersaturated solution is kept the more difficult it is for the copper to escape and in the particular case of copper and aluminium alone, it remains more or less permanently in solution at room temperature, giving a homogeneous, but rather weak, solution of copper in aluminium. If, however, the temperature be raised slightly, the copper commences to come out of solution in the form of sub-microscopic particles of $CuAl_2$, which are distributed fairly evenly through the mass of the metal and are believed to have a cementing or keying effect on the crystal lattice, preventing inter-slip under the effect of stress. This process takes considerable time, the final stable condition not being reached for several days and is known therefore as age-hardening. The theory is now fairly widely accepted that the finer and more evenly distributed these minute particles are, the greater will be the resistance to corrosion, as individually they are too small and numerous to create effective differences of potential against the surrounding metal, which can only take place if they tend to agglomerate or segregate, for instance, at the crystal boundaries. Research has indicated that the lower the temperature to which the alloy is quenched, and the more sudden the quenching, the more complete is the retention of solubility and the consequent fineness and evenness of distribution of the subsequently precipitated particles. This means that, in general, material quenched in cold water is more resistant to corrosion than that quenched in hot water or oil; the latter, having a lower heat conductivity, does not cause such rapid reduction of temperature. If the ageing temperature be raised beyond a certain limit, varying with the nature and amount of precipitation elements present, the particles tend to agglomerate and to form comparatively large crystals, the higher the temperature the larger the particles. Such large particles not only fail to impart the required hardness and strength to the alloy, but also tend to act as nuclei of potential differences, causing the alloy to be less resistant to corrosion. Duralumin contains, in addition to copper, small quantities of magnesium and manganese, as well as still smaller amounts of silicon and iron, which are present as impurities in the virgin aluminium, but which also play an important part in the heat-treatment process. The age-hardening phenomena are, therefore, somewhat more complicated than in the case of the simple aluminium–copper alloy and all the factors involved are probably not yet understood. What is, however, fairly clear is that the metal owes its extreme hardness and strength, far in excess of the simple aluminium–copper alloy, to the precipitation of a number of possibly complex intermetallic compounds, the most important of which appears to be the extremely hard magnesium silicide, Mg_2Si. This readily precipitates out at room temperature, as do the more important of the other compounds, with the result that duralumin is normally age-hardened at room temperature, which is known as natural ageing, instead of at elevated temperatures, known as artificial ageing.

In April, 1928, the American National Advisory Committee for Aeronautics published a very lengthy memorandum, in four parts, giving the results of fairly exhaustive research into the corrosion embrittlement of duralumin, that is, the reduction in strength, but more particularly in the ductility represented by the percentage elongation on rupture, of duralumin after exposure to corrosive influences. This research was carried out at the Bureau of Standards, in co-operation with the National Advisory Committee, the Naval Air Bureau, and the Army Air Corps.

Two types of corrosion were found, surface pitting and intercrystalline, the first type reducing the strength in proportion to the cross-section lost, while the latter, in addition, reduces the breaking stress per effective cross-section and has a still more marked effect on the ductility, due, the authors suggest, to notching effect.

The results of experiments in varying the temperature from which the metal was quenched indicated that some 500° C. was the minimum temperature necessary to obtain optimum mechanical properties, and these properties were little affected by quenching in hot, cold, or iced water, but that there was a marked increase in corrosion resistance in favour of quenching in cold or iced water, there being, however, little difference between the two, ageing being in all cases carried out at room temperature. Further tests on materials aged at 15°, 100°, and 200° C. showed definitely that the propensity to intercrystalline corrosion increased as the ageing temperature was raised. The general conclusions reached, therefore, were that the best results are obtainable from standard composition material, quenched from just over 500° C. in cold water and aged at room temperature. These results have since been more or less confirmed by Sutton and Sidery at the Royal Aircraft Establishment and also by Meissner in Germany, who showed that at just under 100° C. there is a critical temperature of both quenching liquid and ageing, above which a marked decrease in corrosion resistance is experienced, while von Zeerleder in Switzerland has shown that up to 50° C. both for quenching medium and ageing no appreciable increase in corrosion resistance can be detected.

Research, therefore, has shown that duralumin which has been quenched in cold water is more resistant to intercrystalline corrosion than the same material quenched in hot water. One theory put forward to explain this phenomenon is that the more rapid quenching prevents the migration of the precipitated particles to the crystal boundaries, but this is at present only a theory, as indeed is the whole conception of precipitation, which is ridiculed by some workers, though now accepted by most.

Corrosion-fatigue.—Another phase of corrosion research on which attention has recently been focussed is that known as fatigue corrosion, or corrosion-fatigue, according to whether it is the unfavourable effect of alternating stress on resistance to corrosion or the equally damaging effect of corrosion on fatigue strength which one is investigating. If a metal or alloy be subjected to a static tensile or other rupture test, and if the tensile or other load is increased at a fairly rapid rate, the material will break at some definite load or stress. If, however, the load be applied very slowly or maintained for a long time below such breaking load, the specimen will usually break at some such lower load, depending upon a number of factors, such as the amount of cold work which takes place as the result of the extension of the specimen before breaking. Research has shown that for most metals this static endurance limit is, at ordinary temperatures, not materially below the static breaking load and in no circumstances less than half of it, though at elevated temperatures the phenomenon known as creep sets in. This means that a metal can at ordinary temperatures be safely stressed indefinitely up to at any rate half its normal breaking load, though in practice a factor of safety is used to allow for unforeseen circumstances—I have heard it called a factor of ignorance.

If, however, the material be subjected to alternating stresses, which vary between a maximum in one direct and zero, or between a maximum in one direction a a maximum or lower value in the reverse direction, i found that such maximum stress which the mate will withstand indefinitely is, in most cases, considera below what it will withstand if the stress remains const or varies only within narrow limits. The alternat stress which a metal will withstand indefinitely is kno as the alternating endurance limit or simply endurance limit, and the phenomenon connected w this reduction in mechanical properties under cy stress is known as fatigue.

Research has shown that for ferrous materials infin may be taken as 10 million reversals, for if a specin remains unbroken after 10 million reversals of a cert stress, it will withstand that stress more or less definitely, but, unfortunately, there does not appear be any such limit for light metals and it is usua necessary to interpolate the fatigue limit. What however, clear is that the nature of the surface has important bearing on the results, particularly in t reversed bending tests, while any intercrystalline cor sion present effects the results still more. So far insu cient research work has been carried out to enable a hard and fast rules to be given or definitely to correl results with theories, but it seems fairly clear that t effect of such cyclic stress is to increase the corrosi beyond the ordinary and this in turn accelerates fatig

Researches, in Germany and this country, have sho fairly conclusively that, in general, the loss of mechani properties due to simultaneous cyclic stress and corrosi influence is greater than that due to either influe acting separately, and that the relative corrosion p perties of two materials in the unstressed conditi may be completely reversed in the stressed conditi This is probably due to differences in properties of t surface films, particularly differences in strength a elasticity, a strong and/or highly elastic film will stret rather than break under flexure, while a weaker and/ less elastic film will crack and allow corrosive influenc to reach the underlying metal. One point which emerg from all corrosion research is the large influence wh apparently insignificant factors can have on the resul and this is particularly the case with fatigue corrosion

McAdam in America, in a very thorough research in fatigue corrosion, put forward a general theory to t effect that stressless corrosion involves diffusion of t negative ions inward and the metal ions outwa through the film, which he visualizes as always prese and always acting as a deterrent to corrosion. T corrosion of a metal, therefore, depends not only upon t inherent solution pressures, but also upon the porosi of the film, which is, of course, in line with the theori mentioned in the first part of this paper. Stress, wheth cyclic or static, increases the corrosion rate by increasi the permeability or effective porosity of the coatin If the applied stress remains steady, most of th increase in permeability is only temporary, the resulta increased diffusion of ions in both directions very soo repairing the damage done and filling up the enlarg pores, with the result that the corrosion soon falls normal again. If, however, the stress is alternatin there is in each cycle a temporary increase in porosit

even though no actual crack may occur, and this results in a temporary increased rate of diffusion and, therefore, increased corrosion. The greater the stress range the greater is this increase in porosity and, consequently, the greater is the rate of net damage. This is merely one of many contradictory theories put forward to explain this rather puzzling and very annoying phenomenon and anyone wishing to pursue the matter further cannot do better than peruse McAdam's various papers on the subject,[1] and Dr. Gough's excellent review of the whole subject embodied in the 1932 Autumn Lecture before the Institute of Metals.

Prevention of corrosion.—While much research has been carried on to discover the basic causes of corrosion and to develop alloys which by reason of their composition, method of production and working, or their final heat treatment offer the maximum resistance to corrosion, parallel researches have been going on in which methods of treating the surface of such alloys to prevent access of the corroding medium to the underlying metal are being investigated.

The oldest and simplest method of protecting any structural material against the destructive action of air, rain, or sea water is by painting it, but the best of paints have a comparatively short life, particularly when subjected to the combined effect of alternating sun, moisture, and salt over wide ranges of temperature, which tends to loosen the adhesion between the paint and the metal. Paint is also easily damaged. There is still scope for research in this direction, which is, in fact, being actively pursued in all countries ; in this country by the Research Association of the British Paint, Colour, and Varnish Manufacturers at their laboratory at Teddington and by the Corrosion Committees of the Iron and Steel Institute and the Institution of Civil Engineers. The high coefficient of expansion of aluminium alloys must be taken into account in considering all forms of protective coatings and it has been found that certain types of quick-drying enamels used on steel surfaces are insufficiently elastic for light alloys. A few years ago it was thought dangerous to use basic pigments upon aluminium, through fear of chemical reactions, but research has shown these fears to be groundless. Linseed oil, owing to its great flexibility, has proved itself the most suitable medium.

As no form of paint can equal in adhesive or mechanical properties the surface of the metal itself, research has been concentrated for some years past on discovering ways and means of making the surface non-corrosive. The main fields of research may be divided up into three groups, namely :

Metallizing	... ...	Spraying or Rolling.
Plating	... ...	Zinc or Chromium.
Oxidizing	... ...	Chemical or Electrical.

The purer the aluminium the higher the resistance to corrosion, and attempts have been made in Germany to protect alloys by spraying them with pure aluminium but without much success since such sprayed surfaces are by their nature uneven and rather porous, even after subjection to a rolling process.

A more fruitful line of research was followed in America resulting in the production of a thin layer of high purity aluminium rolled into, rather than on to, the surface of duralumin during manufacture, and heat-treated with the latter. This, of course, represents some loss of strength, in the neighbourhood of 10% if both surfaces be treated, as the final heat-treatment anneals the pure aluminium cover, and such material is not immune from attack by alkali, but the pure aluminium has been found to protect the underlying metal at cut edges and deep scratches by electrolytic action. This material, known as Alclad in America and Allautal in Germany, is in regular use for aircraft and appears to be successful.

With Alclad, which is pure aluminium over duralumin, or 17ST, as it is known in the United States, no diffusion appears to take place between the alloy and the aluminium during the heat-treatment, but with Allautal, which is pure aluminium spread over a heat-treated aluminium copper alloy, there is a certain amount of diffusion of copper into the pure aluminium during the much longer soaking at high temperature prior to quenching which this alloy requires, and this may reduce the corrosion resistance.

Another modification of this principle has recently been developed in Germany, using a core of ordinary duralumin containing copper and having optimum mechanical properties, covered by a layer of copper-free duralumin of somewhat lower mechanical strength but higher corrosion resistance. The feature of this material is that both core and covering are heat treatable under the same conditions, thereby reducing to a minimum the loss of tensile strength due to the covering whilst the resistance to corrosion of the copper-free duralumin on the surface is actually increased by the presence of the normal underlying duralumin, to which it is electropositive. Dr. Meissner read an interesting paper on this subject before the Institute of Metals in September, in which he gave the results of some tests which showed that the outer covering of copper-free duralumin acted thus preferentially to a remarkable degree, the underlying core remaining unattacked until the whole of the covering layer had disappeared.

A certain amount of research work on chromium and zinc plating of aluminium alloys has been carried out, notably in this country. Both of these metals can be successfully plated on aluminium, and such plating is being done on a commercial scale for other purposes, but so far neither has been adopted for aircraft work as far as I know. Zinc has been found to give limited preferential protection, pure zinc being, under most conditions, slightly electropositive to duralumin.

Last, but certainly not least, come surface treatments proper, whereby the natural oxide film on aluminium is artificially increased in thickness and density to form a practically impervious and mechanically strong skin. The earliest application of this principle, to my knowledge, was worked more than 20 years ago in Germany by a firm called the Aluminium Spulen A.-G., who produced electric insulating layers of oxide on the surface of aluminium wires by passing them through an electrolytic bath, the wire acting as the anode. In a modification of this process, the wire or strip was first wound into the form of field coils etc. for electric machines and the whole coil afterwards immersed in the bath. Variations of this process, using different liquids or

[1] American Society for Testing Materials.

combinations of liquids, both with and without electric current, have been patented by the score during the last 10 years, but the only ones which have, to my knowledge, been successfully applied to aircraft are the Jirotka process in Germany and the Bengough process in this country, the latter surpassing all other processes from the corrosion-resisting point of view. In the Bengough, or so-called anodic process, a 3% aqueous solution of chromic acid is used; the article to be coated is the anode and the steel tank the cathode, the liquid being maintained at a temperature of 40° C. and the voltage gradually raised from 0 to 50 volts over a period of one hour, during which a dense resistant coating of oxide forms on the surface of the metal. Subsequent application of grease, such as lanoline etc., still further improves the protection against corrosion, probably by filling up any minute pores and by preventing water settling on the surface and causing hydrolizing or peptizing. This process is now so well known and widely applied in the aircraft industry that further reference to it is superfluous, but a full account of the research work carried out on this and other protective coatings at the Royal Aircraft Establishment at Farnborough are given in a paper by Sutton and Sidery.[2]

Another process which gives somewhat less protection against corrosion than the Bengough but more than sufficient for ordinary atmospheric conditions and lends itself particularly to decorative effects by absorption of dyes in the anodic surface uses sulphuric acid as the electrolyte, while a still more recent process developed in Germany uses oxalic acid. Whatever the electrolyte used the covering consists essentially of the hydrated oxide of aluminium in an extremely hard and dense form, with traces only of the salt used as electrolyte, though even this trace may and sometimes does influence, not so much the corrosion resistance, as the power of the film to absorb colouring media and its chemical effect upon such colour.

Corrosion of magnesium.—In addition to the light alloys with an aluminium base, there is another series of light alloys which are now finding some use in the aircraft and transport industries, having magnesium as base. Here, however, the position as regards corrosion is reversed, for, whereas aluminium is unattacked by most acids, but is attacked by alkalis, magnesium is attacked by most acids but unaffected by alkalis. Unfortunately, ordinary air, particularly in industrial districts, usually contains traces of sulphuric acid from the sulphur in the burning coal while salt air contains the elements of hydrochloric acid. In consequence, magnesium alloys are in general far more corrodible than aluminium alloys and much research has been expended in recent years in searching for means of overcoming this fault, but so far without complete success.

As it is under sea-water conditions that magnesium alloys are most subject to corrosion, the greater part of the research has again been devoted to preventing this, either by the addition of corrosion-inhibiting elements to the alloys, by the coating of the alloy with other metals, or the production of a protective film similar to the anodic film on aluminium.

[2] "The Protection of Aluminium and its Alloys against

So far the best alloying results have been obtaine by the addition of small quantities of manganese, whic incidentally, also forms a good corrosion resista alloy with aluminium, but with magnesium the resulta alloy can hardly be called corrosion resistant. N success whatever has, apparently, so far been obtaine in coating magnesium with other metals by such metho as calorising, spraying, etc. and very little succe in the electro-deposition of other metals, such as coppe chromium, or zinc. The method of protecting allo by a covering layer of pure metal which is so successf in the case of certain aluminium alloys has, howeve met with no success whatever with magnesium alloy neither has any really successful anodic process f magnesium yet been discovered.

The greatest success has so far been obtained wi a simple immersion process using as bath an aqueo solution of potassium dichromate, potash alum a caustic soda and the film formed by this method ca be materially further improved by coating with lanoli as in the case of the anodic film on aluminium. The is, however, no comparison whatever between th corrosion resistance of the anodic film on aluminiu which resists both acids and alkalis of almost any kin and strength for long periods, and that of the immersio film on magnesium. There is, therefore, still a larg field of research in this direction, bearing in mind th fact that the corrodibility of magnesium is the greate bar to its more extensive industrial application, part cularly in aircraft where factors of safety are cut so fin

CANADIAN MINING

The Dominion Bureau of Statistics at Ottaw reports that nickel production in Canada last yea including refined nickel, nickel in matte exported an in nickel oxide, totalled 30,327,968 lb., valued a $7,179,862, or considerably less than in 1931. Th year witnessed increased use of four nickel alloys, tw in the nickel cast-iron alloy group, one in nickel cla steel plate, and the fourth was a special chrome-nick alloy developed for dairy use.

Much attention has recently been directed in Canad to the utilization of Canadian building stone in replace ment of material hitherto imported from the Unite States, and the Mines Branch of the Dominion Depart ment of Mines, Ottawa, has issued a report (No. 733 by Mr. F. Goudge, on "Canadian Limestone for Buildin Purposes," which will afford architects information a to the availability of suitable limestones in local deposit

The production in Canada of cobalt (computed a cobalt in metal, in oxides sold, and in ores and residue exported) last year totalled 490,631 lb., valued a $589,062, as compared with 521,051 lb. worth $651,17 in 1931. Exports of cobalt, alloys, cobalt metallic cobalt oxides, cobalt salts, and cobalt ores were value at $589,334, as compared with $735,225 a yea previously.

The Ontario Research Foundation has presented t the Provincial Legislature a detailed report of the lignit deposits recently examined in northern Ontario. N immediate commercial development of the coal i recommended, but a further expenditure of $60,0 for the mining and processing of the fuel is suggest

ARTHUR W. KNAPP

Mr. A. W. Knapp was born in Birmingham more than half a century ago, in the year that Mason College was opened. It was at Mason College that he first studied chemistry, under Prof. Percy Frankland, and Mr. Knapp was one of those to receive the B.Sc. degree at the first degree convocation of the University of Birmingham. Since then he has been awarded the M.Sc. of the University, and is also a Fellow of the Institute of Chemistry and a Member of the Institute of Chemical Engineers.

Although the work of his early years took him to London, Belfast, and Port Sunlight, it is with his native town that he has been associated for the greater part of his career. For a short time he worked under Liverseege in the City Analyst's Laboratory, and in 1911 he joined the staff of Cadbury Bros., becoming chief chemist in 1923, a position which he still holds. His two books on cocoa and chocolate are now well known and he has an international reputation as a writer on subjects relating to the cacao bean; since his first paper appeared in the Journal of the Society in 1910 he has published more than 40 papers on widely diverse subjects.

Mr. Knapp takes a leading part in the various activities at Bournville, particularly in its dramatics section, but he has shown continuous interest in the chemical profession and he has done much work for its advancement. Not only has he been a very active member of the Birmingham Section of the Society, serving on the committee for several periods, but has been a prominent member also of the Councils of the Institute of Chemistry, the Society of Public Analysts, and the British Association of Chemists.

His many friends in the Midlands know him to be happy in the possession of a keen sense of humour, which has found some expression in humorous journalism. Members who visited Birmingham for the Annual Meeting of 1930 will remember to what good purpose this flair was put when he acted as editor of *The Retort*. He recounts also with great pleasure that he succeeded on one occasion in getting a poem published—in CHEMISTRY & INDUSTRY!

SOCIETY OF CHEMICAL INDUSTRY

OFFICIAL NOTICES

Subscriptions. By a new ruling, new members may join the Society for the next six months on payment of a special subscription of £1 7s. 6d., but will receive the JOURNAL only from the present issue onwards. Back numbers may be secured by paying the full subscription of £2 10s.

SYDNEY SECTION

The annual general meeting of the Sydney Section was held in Science House, Sydney, on May 10, Prof. J. C. Earl occupying the chair. The annual report of the committee disclosed a satisfactory position of the affairs of the section, both the membership and the average attendance at meetings showing increases during the year. During the session the Section held five meetings, the papers presented being as follows:

May 18. Prof. J. C. Earl. "The Future of Chemical Industry in Australia."

July 20. Mr. W. Millership, B.Sc. "The History of p_H and Important Industrial Applications."

Sept. 14. Mr. D. G. Darroch. "Recent Developments in the Formulation and Testing of Paint Protective Films."

Oct. 19. Mr. R. A. Davidson. "The Edible Oil Industry in Australia."

Nov. 30. Mr. F. H. E. Cliff. "The Petroleum Oil Industry."

The meeting on October 19 was a joint meeting arranged by the Section in association with the Australian Chemical Institute, the Sydney University Chemical Society and the Technical College Chemical Society, and these four bodies propose to hold two further joint meetings in the forthcoming session, an obvious indication of the success of the initial collaborative effort. The papers were in every case of great interest and value and the section was greatly indebted to the lecturers for their services in preparing and presenting their much appreciated communications.

At the conclusion of the session, the Section had 46 members in the Metropolitan area, an advance on the previous year, and evidence of the beginning of the effects of the constructive work of Prof. J. C. Earl to whom the Section is very much indebted for his services as chairman during the past two years. The meeting carried a cordial vote of thanks to Prof. Earl for his work.

The officers elected for the ensuing year were as follows:

Chairman: Mr. H. G. Farnsworth; *Vice-Chairman:* Prof. J. C. Earl; *Secretary and Treasurer:* R. K. Newman; *Committee:* Messrs. A. D. Olle, H. V. Bettley-Cooke, H. Finnemore, W. D. Mackenzie, F. A. Coombs, G. H. Adam, E. S. Stokes, A. W. Thomson, A. Willis.

At the conclusion of the business session, Prof. Henry Priestly delivered an address on "The Conservation of Vitamins in Food Manufacture." The lecturer spoke on the nature and occurrence of the different vitamins, and the probable chemical structure of the more important members. He stressed the necessity for assaying

*the vitamin content of prepared foods, particularly those used for the feeding of infants. With the increasing consumption of factory prepared foodstuffs as opposed to home-prepared, it behoved the manufacturers to see that their products were at least as good as the home-prepared article in all respects and not least in their content of vitamins. To this end manufacturing methods which caused the least destruction of the vitamins of the raw product should be used. A discussion in which many members participated followed the address, and a cordial vote of thanks to Prof. Priestly was carried by the meeting.

CORRESPONDENCE

EBONITE IN FACTORY EQUIPMENT

SIR.—Your note on page 529 of last issue (June 23) would give the impression that ebonite covering of centrifugal baskets is a new departure. At Silvertown this work has been carried out for some 25 years, and at the present time baskets 72 in. in diameter are dealt with in the ordinary way of business—a procedure involving the drilling of over 3000 holes.

It is, however, a fact that formerly many centrifugal baskets were sent abroad for covering, but users are realizing that satisfactory work can be carried out in this country. The adhesion and flexibility of our ebonite coverings may be judged from the fact that when recently a covered basket was accidentally dented it was trued up by levering out the side and hammering it to shape after which the usual electrical test of 1200 volts A.C. was successfully passed.

I am, Sir, etc.,

H. J. STERN

The India Rubber, Gutta Percha and Telegraph Works Co., Ltd.,
Silvertown.
June 27, 1933

SIR,—On looking through the issue of CHEMISTRY & INDUSTRY for June 23, under "General Notes" on page 529, is a reference to an application of ebonite to the hydro-extractor.

From the paragraph it would appear that this application is an innovation in this field, but we would point out that we have been carrying out work of this type for a considerable number of years.

We are, Sir, etc.,
per pro. David Moseley & Sons, Ltd.,
WM. S. DICKIE

Manchester,
June 27, 1933

PERSONAL AND OTHER ITEMS

Dr. J. C. Mann, of Robinson Bros., Ltd., West Bromwich, and Midland Tar Distillers, Ltd., the well-known member of the Birmingham Section of the Society, has been elected a Member of the Institution of Chemical Engineers.

The University of London has conferred the title of University Professor of Pharmacology on Dr. J. H. Burn, in respect of his post at the College of the Phar-

Mr. K. S. Krishnan, reader in physics in the University of Dacca, has been elected secretary of the Indian Association for the Cultivation of Science in succession to Sir C. V. Raman.

Dr. John Thomas, joint managing director of the dyestuffs group of Imperial Chemical Industries, Ltd., left estate of the gross value £13,264, with net personalty £12,488.

Col. C. E. Brigham has been appointed to succeed Maj.-Gen. H. L. Gilchrist as head of the U.S. Chemical Warfare Service.

We regret to learn of the death recently of Dr. E. H. S. Bailey, Emeritus professor of chemistry and metallurgy of Kansas University.

We regret to learn of the death in America on June 5 of Dr. Lloyd Balderston, a past president of the American Chemical Society.

The death took place recently of Mr. Charles Reed, one of the founders of the Electrochemical Society of America and its first secretary.

We regret to learn of the death on June 20 of Senator Philippe Paradis, president of the Asbestos Manufacturing Co., and a life governor of Laval University of Quebec.

We regret to learn of the death on June 26 of Mr. H. R. A. Mallock, F.R.S., for many years a member of the Advisory Committee for Aeronautics and Consulting Engineer of the Ordnance Board.

Beilby Memorial Awards

The administrators of the Beilby Memorial Fund (the presidents, honorary treasurers, and secretaries of the Institute of Chemistry, the Society of Chemical Industry, and the Institute of Metals) have announced the award of 100 guineas each to Dr. Constance F. Tipper (*née* Elam), of the Engineering Department, Cambridge University, and to Dr. A. J. V. Underwood, chemical engineer.

Dr. Elam (Mrs. G. H. Tipper) was educated at Newnham College, Cambridge. From 1917 to 1927 she worked at the Royal School of Mines, South Kensington, as research assistant to Prof. Sir Harold Carpenter, F.R.S. In 1924 she was elected Armourers' and Brasiers' Research Fellow in metallurgy and held this Fellowship for the maximum period of five years, and since 1928 has conducted research in the engineering department of Cambridge University. Dr. Elam has published twenty-one papers, including six in conjunction with Sir Harold Carpenter, three in conjunction with Prof. G. I. Taylor, F.R.S., and twelve independent publications.

Dr. A. J. V. Underwood was educated in the University of Leeds and was a Research Scholar from 1918 to 1920. He took a post-graduate chemical engineering course at the Imperial College of Science and Technology, London, from 1920 to 1921, and qualified as a member of the Institution of Chemical Engineers, on which body he has since served as a member of council and examiner. He is at present practising as a consulting chemical engineer, and is an honorary lecturer in the Ramsay

London. Dr. Underwood has published a large number of papers on chemical engineering subjects, notably in connexion with *filtration, distillation,* and *flame temperatures.* His treatment has been mainly mathematical and he has developed original quantitative methods for interpreting and applying basic chemical engineering processes.

Chemical Society's Library

The library of the Chemical Society will be closed for stocktaking from Monday, August 7, until Saturday, August 19, inclusive, and will close each evening at 5 o'clock from August 21 until September 16.

Ramsay Laboratory of Chemical Engineering

Prof. W. E. Gibbs was entertained to dinner on June 30 by the staff and students of the Ramsay Laboratory on the occasion of the successful conclusion of the second year of occupation of the new building. In proposing the toast of the guest, Capt. A. I. Wynne-Williams said that the growth of chemical engineering education and the widespread realization of the chemical engineer's place in industry had been due in no small part to the advocacy of Prof. Gibbs.

University News

Birmingham.—The University has conferred the degree of *D.Sc.* (oil engineering and refining) on A. R. Bowen, and *D.Sc.* (chemistry) on F. J. Warth. The following have been awarded the degree of *Ph.D.* (chemistry): R. G. Ault, R. W. Herbert, G. H. Preston, and H. Saenger. Priestley Scholarships in Chemistry have been awarded to T. H. Goodwin and Elsie Oliver (renewal), and the Frankland Medal and Prize has been awarded to J. K. N. Jones.

Edinburgh.—At the graduation ceremony on June 30 the honorary degree of LL.D. was conferred on Sir Henry H. Dale, Director of the National Institute of Medical Research, and Sir Alexander C. Houston, of the Metropolitan Water Board.

Glasgow.—The Senate of the University has awarded the degree of *Ph.D.* in the faculty of science to D. McCreath, for his thesis "The Optical Rotatory Power of Certain Tartrates." Other degrees awarded by the University include:—*B.Sc. (Hons.)—In Pure Science,* (first-class honours in chemistry), S. C. Carson, Helen G. Dunlop, J. M. Garven, W. Harkness, A. H. Lamberton, J. S. McFadyen, and Janet M. Murdoch; *B.Sc. (Hons.)—In Applied Chemistry,* J. F. C. Gartshore, R. C. Wood, H. M. Finniston, Nora I. McGhee, and R. Graham.

Leeds.—The University has awarded the degree of *Ph.D.* to the following: (in chemistry) J. B. M. Coppock, N. B. Dyson, Constance Higginbottom, and O. V. Richards; (in textile chemistry) C. A. Cooper; (in colour chemistry) W. G. Dangerfield and W. C. Dovey; (in dyeing) C. H. Giles; (in agricultural chemistry) R. S. Gupta and H. Paver.

Manchester.—The Sir Clements Royds Memorial Scholarship in chemistry has been awarded to Mr. R. Preston. It is announced that the Rockefeller Foundation has made a grant to enable the research section of the Faculty of Commerce and Administration to enlarge its activities.

Sheffield.—The University has awarded the following degrees: *Ph.D.* (engineering)—W. E. Cooke, J. Dick, E. Preston, and R. Wigginton; *Ph.D.* (metallurgy)—R. W. France; *D. Met.*—R. Genders; *M.Sc.* (chemistry)—C. C. Howis.

Storage of Metals in Livers of Mollusca

It has long been known that oysters and other shellfish can accumulate notable amounts of arsenic and copper. From a paper by Mr. Hugh Ramage, quoted in *Nature* of June 24 last, it seems that the edible snail accumulates manganese in its liver and that *Pinna pectinata* accumulates silver in its liver; silver was present in every liver of crabs and lobsters examined, and caesium was always found in the liver of the common scallop.

World Petroleum Congress

Prior to the official opening of the World Petroleum Congress at the Imperial College of Science on July 19 next, there will be a reception of delegates and members by Mr. T. Dewhurst, President of the Institution of Petroleum Technologists, at the Science Museum, South Kensington. The British Government is to hold an official reception of the delegates at 10 p.m. on the following day. In addition to the formal sessions of the Congress, at which nearly 150 papers will be presented and discussed, there will be two lectures by Mr. J. G. Aug. Kessler and Sir John Cadman at the Royal Institution on July 20 and 21 respectively. Full particulars of the programme of the Congress can be obtained from the Secretary of the Institution of Petroleum Technologists, Aldine House, Bedford Street, London, W.C.2.

British Metallurgists in America

The 64th meeting of the American Electrochemical Society, which is to be held in Chicago in September, marks the hundredth anniversary of Faraday's discovery of his two fundamental laws of electrochemistry. Prof. R. S. Hutton has been invited to deliver the Faraday address. A session on corrosion will also be held during the meeting, and Dr. U. R. Evans and other European metallurgists will take part in the discussion.

Dr. H. J. Gough, F.R.S., has been invited by the American Society for Testing Materials to give the Society's eighth Edgar Marburg Lecture at the annual meeting, which is being held in Chicago at the end of June. Dr. Gough will speak on "Crystalline Structures in Relation to Failure of Metals, Especially by Fatigue."

Researches on Coal and Coke

The Annual Report (No. 4, 1932) of the Northern Coke Research Committee which has recently been published is a record of considerable progress, achieved in spite of the fact that the income of the committee has been considerably reduced as the result of a reduction in the Government grant. A very thorough examination has been made of the agglutinating test for coal and valuable information regarding the causes of variations of the determined agglutinating indexes has been furnished to the British Standards Institution. Work on the evaluation of coking coals and coal mixtures has indicated a tendency for low volatile matter content to be associated with high shatter index of the corresponding coke prepared in the experimental coke ovens, which

confirms similar observations made by the Scottish Coke Research Committee. The experimental errors of routine tests have been examined and found to be unexpectedly high in some instances, *e.g.*, the determination *of carbon. A detailed report of these investigations* is to be published shortly.

The Committee has also assisted the British Standards Institution in the preparation of standard methods for the examination of coke. Methods for the determination of apparent specific gravity were found to be affected by unduly large errors and more trustworthy methods are being examined. Amongst other items included in the research programme for the future are the examination of cokes suitable for domestic purposes, and the examination in the cupola of cokes prepared under different carbonizing conditions.

Housing Research

At a meeting held recently at the offices of the Chartered Surveyors' Institute it was decided to form a council for research in housing construction, and to bring together industrial, professional, and other interests to study this problem. The council, of which Lord Melchett is a member, is under the chairmanship of the Earl of Dudley.

British Standard Specification for Ebonite

The third edition of the B.S. Specification for ebonite shows some interesting changes as compared with the 1931 edition. The use of "accelerators" and loading materials is no longer prohibited, but excessive proportions of such substances are prevented indirectly by the electrical tests. Consequently, although the composition of the ebonite is no longer specified, compliance with the tests ensures that the material is substantially composed of good-quality raw rubber and sulphur.

Some changes have been made in the permissible impurities, mechanical strength and electric strength, and modifications have been introduced in the technique of the electric strength and power-factor tests. Adjustments have also been made as regards the tolerances on dimensions.

Copies of this specification (B.S.S. No. 234—1933) may be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s. 2d., post free.

Mineral Production of N.S. Wales

According to the New South Wales Under-Secretary for Mines, the value of metals and minerals obtained during 1932 was £7,313,996, a slight falling off in comparison with the previous year being due mainly to the lessened price of coal.

The value of the output accruing to the State of silver, *silver-lead ore and concentrates, and zinc concentrates,* amounted to £1,722,840, representing an increase of *£130,686 in value over that of 1931.*

The gold yield amounted to 27,941 oz. fine, the value at the standard rate being £118,685, equivalent to an increase of 8268 oz. fine and £35,120 in value as compared with the previous year, and the highest yield recorded since 1921.

The output of Portland cement, which dropped from 169,021 tons, valued at £617,432, in 1931, to 114,432 t., valued at £390,715, in 1932, was a reflection of buildi trade conditions.

Indian Notes

Soap works in Bombay.—A company has been form in Bombay to manufacture some of the soaps at prese exported from the factories of Lever Bros. and th associated companies in England, and a considera area of land has been acquired. Plentiful supplies Indian vegetable oils, similar to those used in Englan are available in India, and the high standard of quali which has resulted in the development of a large a increasing business in these soaps should be maintain by the new Indian factory.

Science exhibition in Bangalore.—A science exhibiti was recently organized by the South Indian Scien *Association and the Society of Biological Chemist* India, in connexion with their joint conference he in Bangalore. The exhibition, which was on a muc bigger scale than anything previously attempted i South India, was held to demonstrate to both laym and scientists the fundamental principles of optic electricity, television, zoology, geology, applied physi and chemistry, biochemistry, medicine, and pathology.

Adulteration with groundnut oil.—A recent publicati of the Madras Government entitled "Groundn and its Uses," by Mr. A. K. Menon, Government Chemis deals with the use of *groundnut oil, which is a compar* tively cheap oil produced in large quantities in t *Madras Presidency, as an adulterant. It is largely use* in South India to adulterate gingelly oil. When cocon oil is dear, groundnut oil is mixed with it and it is al used to adulterate castor oil. Groundnut oil is ofte employed as a substitute for olive oil.

Chemical industry in Baroda.—Baroda, the large State in Western India, is making rapid industri progress and particular attention is now being give to the promotion of chemical industries. This State wa the first in India to establish a technical school. Th school is now more than 50 years old and has contribute *materially to industrial advancement.* The Durbar ha now decided to start a new Science Institute and *building is already being constructed. In this Institut* students will be given post-graduate instruction i science, and special emphasis will be placed on industri chemistry.

The Centenary of Niépce

The *Société Française de Photographie et de Cinema ographie* recently commemorated at Chalon-sur-Saôn the hundredth anniversary of the death of Josep Nicéphore Niépce, one of the pioneers of photograph Niépce was the first to establish a process of photograph that gave pictures subsequently unaffected by ligh He showed in 1814 that a thin film of bitumen, aft prolonged exposure to light, became insoluble in it *most usual solvents*; thus he produced an image on bitumen-covered plate by long exposure in a camer followed by "development" in a mixture of whit petroleum and lavender oil, which dissolved the bitume unaffected by light. The commemoration at Chalon sur-Saône was attended by M. de Monzie, Ministe Education, by a number of French scientists, and b Dr. Jean Niépce, a descendant of Niépce.

REVIEWS

…LYSIS AND ITS INDUSTRIAL APPLICATIONS. By E. B. Maxted, D.Sc., Ph.D., F.I.C. Pp. xii + 529. London: J. & A. Churchill, 1933. 36s.

…n increasing interest is being taken in the question …catalysis: Bristol University, for example, has a …cial lecturer on the subject with the result that we … now given the material collected for his lectures in …ok form. Dr. Maxted has himself been a not unsuccess…l worker in this field on its technical side and we can …y therefore on his information being carefully sifted …d presented in a manner suitable for technical readers.

The book is arranged in two parts, one theoretical, the …her industrial. It is now customary to divide catalytic …actions under four headings, reduction, oxidation, …dition or elimination of water, and others. Whereas … the industrial application hydrogenation at first led … importance, increasing attention is being paid to the …her aspects.

In the second part Dr. Maxted deals with ammonia …nd its oxidation to nitric acid, the hydrogenation of …s, sulphuric acid, and some processes connected with …el, which include the manufacture of hydrogen. Com…leteness combined with brevity is the keynote of the …ook; it contains an unusually large number of inform…ive tables and the customary references to the original …terature. In our opinion the author has done his …sk exceedingly well and succeeded in producing a most …adable book. In discussing ammonia synthesis, for …xample, the sequence provides information regarding …roduction, general arrangement of plant, the ammonia …quilibrium with tables, the kinetics of the synthesis, …e influence of pressure, technical catalysts with more …bles, types of synthesizing furnace, the elimination …f ammonia from the circuit gases, the manufacture …nd purification of the component gases, the modifi…ations of the original Badische process, analytical …ontrol and safety devices, and the synthesis of alkali …yanides, all within the space of 32 pages. At the end of …e description the reader feels confident that he has …astered all the salient points of this remarkable process. …iscellaneous processes such as are in the forefront of …terest at the present time receive only brief treatment.

The theoretical section occupies nearly four-fifths of …e book and deals with all aspects of the subject. One …f the most valuable chapters is that devoted to the …ethod of preparation and principal uses of the com…moner catalysts; after dealing with the platinum …roup, nickel and iron, the remaining elements are …nsidered in the order of their groups in the periodic …stem.

We shall expect this book, in spite of its price, to …come the leading treatise on catalysis. E. F. A.

…N SOLDERS: A MODERN STUDY OF THE PROPERTIES OF TIN SOLDERS AND SOLDERED JOINTS. By S. J. Nightingale. Introduction by R. S. Hutton, D.Sc. Pp. viii + 89. London: British Non-Ferrous Metals Research Association, 1932. 5s.

has brought such clarity and progress in other fields. A book containing a systematic study of solders is therefore very welcome. In "Tin Solders," Mr. Nightingale has written primarily for the user, but the book will be valuable also to the metallurgist who wishes to grasp quickly the essentials of the subject.

The first chapters of the book contain a clear exposition of the nature and physical properties of solder alloys, and should prove of very definite interest to the craftsman. Such important and such skilled manipulative work as soldering has become, deserves special explanations of the structural, thermal, and mechanical fundamentals of these alloys. A detailed consideration then follows of the various factors which influence the strength of joints, a standardized form of test joint being the basis of much experimental work. In criticism it is felt that additional force would have been gained if the numerous photographs used in illustration had been more skilfully prepared.

The remainder of the book is devoted to more practical considerations concerning fluxes, wiped joints, and choice of solders, the latter being focussed around a list of the new British Standards Institution's specifications. A bibliography which is inclnded as a guide to the more advanced pursuit of the subject completes a sound little volume.

I.-G. DEUTSCHLAND: EIN STAAT IM STAATE. By H. Wickel. Pp. 224. Berlin: Verlag Der Bücherkreis, G.m.b.H., 1932. 4,30 rm.

The "leitmotiv" of Helmut Wickel's book is the rôle played by the "Interessengemeinschaft Farbentrust" (abbreviated to I.G.) in the political and economic life, not only of Germany, but of the world. The I.G. has become a State within a State and the history of its growth, as the author tells it, will interest alike the chemist, the economist, and the general reader. As an introduction we are given a rather journalistic account of a visit to the works at Leuna. This factory of the I.G. was erected during the war for the production of synthetic ammonia and its oxidation to nitric acid. This introduction does not harmonize with the rest of the book; most chemical works are similar and forbidding when viewed from an æsthetic standpoint. From this point, however, the author forgets journalism and traces the beginning of chemical industry which resulted from the initial discoveries of the pioneers such as Priestley, Pierre Bayen, Cavendish, and Lavoisier.

We are given an account, with interesting and little-known sidelights, of the return of Liebig from France after working with Gay-Lussac, and the founding by him of the first University Chemical Laboratory at Giessen in 1825. Then follows the sojourn of his pupil, A. W. Hofmann, in England, the initial discovery of W. H. Perkin and the much discussed question why the synthetic dyestuff industry did not take root in England. The book is prolific in quotation and here is cited a speech made by Duisberg in 1906. "The English, in general so practical, fail in that which is characteristic of the German, we will not say persever-

ammonia industry, in a lecture on the "Badische Anilin und Sodafabrik" delivered to the "Verein der deutschen Chemiker" in 1921, "How does it come about that only with us is such a development possible? Why does each of us work with such endurance and patience through the long years of uncertainty, of doubt of ultimate success and personal sufficiency? In the end perhaps it is only because it cannot be otherwise. It is in our blood, it is therefore no merit but a characteristic and peculiar quality." Another factor adduced was the formulation of benzene. The industry thrived so well on congenial soil that at the beginning of the century the six largest German chemical concerns employed over 500 chemists and about 150 technologists and engineers. Finally, the latter part of the book deals with the International position of the Trust, especially with regard to nitrogen fixation, coal hydrogenation, and the ramifications due to over-production and tariff barriers. Altogether the book is very readable, even if we feel that in places but half the story has been told. W. H. P.

MITTEILUNGEN DER TEXTILFORSCHUNGSANSTALT KREFELD E.V. Vol. VII, 1931. Pp. 68. Krefeld: M. Buscher, 1931.

The papers in this collection from the Research Institute at Krefeld have previously appeared in "Seide." They contain no revelations of outstanding importance, but are evidently intended to be of general interest and assistance to the textile technologist who in these days must be something of a chemist and something of a physicist to understand the properties and behaviour of the many new synthetic materials he is called on to handle. Two papers are concerned with natural silk, Dr. W. Wagner discussing the functions of the different glands of the silkworm and the relation of the structure of the fibre to the spinning mechanism, whilst H. Pohl discusses the effect of different weighting materials on the swelling of the silk fibre. The other papers, apart from one on colour measurement by W. Ginzel, discuss some of the current developments and problems in rayon technology. The vagaries of the sheep, of the silkworm and of the cotton plant are insignificant compared with those of the artificial silk plant. Viscose silk is particularly liable to variations, beyond manufacturing control, which reveal themselves when the material comes to be dyed, and the colour-chemist has been called on to devise dyes which will mask the defects of manufacture by dyeing uniformly level shades in spite of the variations. Dr. K. Schulze reviews the constitutions of the dyes which have been patented for the purpose, mostly of British origin, and concludes that the solution of the problem of dyeing level shades has been obtained at the expense of the fastness of the dyed viscose to water, since the affinity of the dye for the cellulose has had to be reduced. The difficulties encountered in the manufacture of artificial silk crêpe and in dyeing the fabric are discussed by Dr. W. Weltzien and others, and Dr. F. Loewy describes a number of new mixed fabrics of cotton and "vistra" with viscose and acetate silk.

E. H. RODD

COMPANY NEWS

BAKER PERKINS, LTD.

The annual report of the company, manufacturers of food, chemical, and laundry machinery, for 1932, records a net profit of £66,222, an increase of £11,155 as compared with 1931. Including £2154 brought in from long credit suspense account, the total profit is brought to £68,376. A final dividend of 3% is recommended, making the total for the year 6% as last year. It has been decided to close the Willesden works of the company, centralizing production at Peterborough, and it is hoped to complete the removal before the end of this year.

BRITISH GLUES & CHEMICALS, LTD.

The report of the company for the year ended April 30, 1933, records a net profit of £45,361, an increase of £13,893 compared with the previous year. With £31,65[illegible] brought in, the total available for distribution is £77,02[illegible] as compared with £56,659 last year. Preference dividend has been paid to April 30, 1933.

EDGAR ALLEN & CO.

The net loss of the company for the year ended March 31, 1933, was £34,675, which follows a net loss of £11,053 in the previous year. The total debit balance now carried forward is £77,825. Dividend on the 5% cumulative preference shares is now in arrear from April 1, 1931.

DRUG INCORPORATED

The board of directors of Drug Incorporated, the American company which until recently held a controlling interest in Boots Pure Drug Co., has recommended the dissolution of the corporation and the re-establishment of its five principal subsidiaries as independent companies. These five are Sterling Products, Inc. United Drug Co., Bristol-Myers Co., Vick Chemical Co., Life Savers, Inc. A special meeting of stockholders is to be held on August 7 to bring the proposal into effect.

Drug Incorporated is at present the largest manufacturing and distributing organization in the pharmaceutical industry. The annual report for 1932 showed net profits of $13,467,092, and the total assets $150,627,017.

ALLIED CHEMICAL AND DYE CORPORATION

It is reported by *The Financial Times* that a group of shareholders is endeavouring to acquire control of the corporation for the Solvay interests, who at present own 20% of the corporation's stock. The difference between the cost and the current market value of the corporation's holdings of Government and other marketable securities is now $8,000,000.

TAYLORS (CASH CHEMISTS) TRUST, LTD.

The revenue of the trust for the year ended March 31 was £42,119, as compared with £51,231 in the previous year. It is now proposed that 440,000 preferred ordinary shares shall participate in 75% of the balance of profits available until a maximum of 12½% has been paid each year. The balance of the existing preferred ordinary shares will be converted into fully paid 6% cumulative preference shares.

MARKET REPORT

Market Report is compiled from special information received from the manufacturers concerned.

Unless otherwise stated, the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acid Acetic, 40% tech.—£20 5s. per ton d/d address U.K. in casks.

Acid Chromic.—11d. per lb., less 2½% d/d U.K.

Acid, Hydrochloric.—Spot, 3s. 9d.—6s. per carboy d/d according to purity, strength, and locality.

Acid, Nitric 80° Tw.—Spot, £18—£25 per ton makers' works, according to district and quality.

Acid, Sulphuric.—Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 60s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., *Non-arsenical, £6 15s. per ton.*

Ammonia (Anhydrous).—Spot, 10d. per lb. d/d in cylinders.

Ammonium Bichromate.—8d. per lb., d/d U.K.

Bisulphite of Lime.—£6 10s. per ton. f.o.r. London, packages free.

Bleaching Powder, 35/37%.—Spot, £8 15s. per ton d/d station in casks, special terms for contracts.

Borax, Commercial.—Granulated, £15 10s. per ton; Powder, £17 per ton. (For 1-ton lots and upwards, packed in 1-cwt. bags, carriage paid any station in Great Britain.)

Calcium Chloride, Solid, 70/75%.—Spot, £5 5s. per ton *d/d station in drums.*

Chrometan.—Crystals, 3½d. per lb.; Liquor, £19 10s. per ton d/d U.K.

Chromium Oxide.—10d.—10½d. per lb., according to quantity, d/d U.K.

Methylated Spirits, 61 O.P.—Industrial, 1s. 8d.—2s. 3d. per gal.; Pyridinized Industrial, 1s. 10d.—2s. 5d. per gal.; Mineralized, 2s. 9d.—3s. 3d. per gal. 64 O.P. 1d. extra in all cases. Prices according to quantity.

Nickel Sulphate.—£49 per ton d/d.

Nickel Ammon. Sulphate.—£49 per ton d/d.

Potash, Caustic.—£30—£33 per ton. Potass. Bichromate crystals and granular.—5d. per lb., net d/d U.K., for spot. Discount according to quantity. Ground, 5¾d. per lb.

Potassium Chromate.—6½d. per lb., d/d U.K.

Sal ammoniac, Firsts lump.—Spot, £42 17s. 6d. per ton d/d address in barrels. *Chloride of Ammonia.*—£37—£45 per ton, carr. paid.

Salt Cake, unground.—Spot, £3 15s. per ton d/d station in bulk.

Soda Ash, 58° E.—Spot, £5 17s. 6d. per ton, f.o.r. in bags, *special terms for contracts.*

Soda, Caustic, solid 76/77° E.—Spot, £14 5s. per ton d/d station in drums, special terms for contracts.

Soda crystals.—Spot, £5—£5 5s. per ton d/d station or ex depôt in 2-cwt. bags.

Sod. Acetate 97/98%.—£21 per ton. Sod. Bicarbonate (refined).—Spot, £10 10s. per ton d/d station in bags. Sod. Bichromate Crystals, Cake, and Powder.—4d. per lb., net d/d U.K., discount according to quantity. Anhydrous 5d. per lb. Sod. Bisulphite Powder 60/62%.—£16 10s. per ton delivered, 1-cwt. iron drums for home trade.

Sod. Phosphate.—£12 10s. per ton, f.o.r. London, casks free. Sod. Silicate 140° Tw.—Spot, £8 5s. per ton d/d station, returnable drums. Sod. Sulphate (Glauber's Salt).—Spot, £4 2s. 6d. per ton d/d. Sod. Sulphide solid, 60/62%.—Spot, £10 15s. per ton, d/d in drums. Crystals, 30/32%.—Spot, £8 per ton, d/d in casks. Sod. Sulphite, Pea Cryst.—Spot, £13 10s. per ton, d/d station in kegs; Commercial.—Spot, £9 10s. per ton, d/d station in bags.

RUBBER CHEMICALS

Antimony Sulphide.—Golden.—6½d.—1s. 1½d. per lb., according to quality. Crimson.—1s. 3d.—1s. 5d. per lb., according to quality.

Arsenic Sulphide, Yellow.—1s. 5d.—1s. 7d. per lb.

Barytes.—£7 10s.—£9 per ton, according to quality.

Cadmium Sulphide.—2s. 9d.—3s. 1d. per lb.

Carbon Bisulphide.—£30—£32 per ton, according to quantity, drums extra.

Carbon Black.—3¾d.—4⅝d. per lb., ex wharf.

Carbon Tetrachloride.—£41—£46 per ton, according to quantity, drums extra.

Chromium Oxide, Green.—1s. 2d. per lb.

Diphenylguanidine.—2s. 2d. per lb.

India-rubber Substitutes, White.—4½d.—4⅝d. per lb. Dark.—3½d.—4½d. per lb.

Lamp Black.—£45—£48 per ton.

Lead Hyposulphite.—9d. per lb.

Lithopone, 30%.—£17 10s.—£18 per ton.

Mineral Rubber "Rupron."—£18 10s. per ton.

Piperidine Rubber Accelerators.—P.P.D.—10s. 6d.—11s. 6d. per lb.; Z.P.D.—7s.—7s. 6d. per lb.; L.P.D.—6s. 6d.—7s. per lb.; P.T.D.—9s. 8d.—10s. 4d. per lb.; C.P.D.—8s. 3d.—8s. 10d. per lb.; S.P.D.—8s. 1d.—8s. 7d. per lb.; P.T.M.—11s. 6d.—12s. 6d. per lb.

Sulphur.—£11 10s. per ton. Sulphur Precip. B.P.—£55—£60 per ton. Sulphur Precip. Comm.—£50—£55 per ton.

Sulphur Chloride.—5d.—7d. per lb., according to quantity.

Vermilion, pale or deep.—4s. 3d.—4s. 5d. per lb.

Zinc Sulphide.—11d.—1s. per lb., according to quality

WOOD DISTILLATION PRODUCTS

Acetate of Lime.—Brown, £8 10s.—£8 15s. per ton. Grey, £13—£14 per ton. Liquor, Brown, 30° Tw., 6d. per gal.

Amyl Acetate, technical.—95s.—110s. per cwt.

Charcoal.—£6—£11 per ton, according to grade and locality.

Methyl Acetone, 40/50%.—£50—£52 per ton.

Wood Naphtha.—Miscible.—2s. 7d.—4s. per gal. Solvent, 3s. 9d.—4s. 9d. per gal.

Wood Tar.—£2—£6 per ton.

Wood Creosote.—6d.—2s. per gal.

TAR PRODUCTS

Acid Carbolic.—Crystals.—9d.—10d. per lb. Crude 60's, 2s. 5d.—2s. 6d. per gal. 2% water—3s. 0¾d. per gal.

Acid Cresylic, 99/100.—11d.—1s. 8d. per gal., according to specification. Refined, 1s. 7d.—1s. 8d. per gal. Pale, 98%, 1s. 2d.—1s. 3d. per gal. 95%, 11d.—11½d. per gal. Dark, 10d. per gal.

Anthracene Oil, Strained, 4½d. per gal.

Benzole.—Prices at works: Crude, 9d.—9½d. per gal.; Standard motor, 1s. 4d.—1s. 4½d. per gal.; 90%, 1s. 5d.—1s. 6d. per gal.; Pure, 1s. 7½d.—1s. 8d.

Creosote.—B.S.I. specification, 3d. per gal., d/d. *Heavy*—4d. per gal.

Naphtha.—Solvent, 90/160, 1s. 4d.—1s. 5d. per gal. *Solvent 95/160, 1s. 7d. per gal. Solvent 90/190,* 9d.—1s. 1d. per gal.

Naphthalene.—Purified crystals, £9 10s. per ton in bags. Crude, Hot Pressed, £6 5s. per ton. Flaked,

Pitch, medium, soft.—80s. per ton, in bulk at makers' works.

Pyridine.—90/140—4s.—4s. 6d. per gal.; 90/180—2s.—2s. 3d. per gal.

Toluole.—90%, 2s.—2s. 1d. per gal. Pure, 2s. 4d. per gal.

Xylol.—1s. 11d.—2s. per gal. Pure, 2s. 2d.—2s. 3d.

PHARMACEUTICAL AND PHOTOGRAPHIC MATERIALS

Acid, Acetic, Pure 80%.—£39 5s. per ton d/d address U.K. in casks.

Acid, Acetyl Salicylic.—2s. 9d.—2s. 11d. per lb., *according to quantity.*

Acid, Benzoic, B.P.—1s. 9d.—1s. 11d. per lb. *Solely* ex Gum.—1s. 3d.—1s. 6d. per oz.; 50-oz. lots, 1s. 3d. per oz.

Acid, Boric, B.P.—Cryst., £35 10s. per ton. Powder, £36 10s. per ton. Ex-Fine Powder, £38 10s. per ton. For 1-ton lots and upwards, packed in 1-cwt. bags, carriage paid any station in Great Britain.

Acid, Camphoric.—19s.—21s. per lb.

Acid, Citric.—9½d. per lb. Less 5%.

Acid, Gallic.—2s. 9d. per lb. for pure crystal in 1-cwt. lots.

Acid, Molybdic.—5s. 3d.—5s. 9d. per lb., according to quantity.

Acid, Pyrogallic, Cryst.—6s. 9d. per lb. for 1-cwt. lots. Resublimed.—8s. 6d. per lb. for 28-lb. lots d/d.

Acid, Salicylic.—B.P. pulv., 1s. 7d.—1s. 10d. per lb. Technical, 1s. 2d.—1s. 4d. per lb.

Acid, Tannic, B.P.—3s. 9d. per lb.

Acid, Tartaric.—11¾d. per lb. Less 5%.

Acetanilide.—1s. 5d. per lb.

Ammon. Benzoate.—3s. 3d.—3s. 9d. per lb.

Ammonium Hippurate.—19s. 6d.—23s. 6d. per lb.

Ammonium Iodide.—17s.—17s. 6d. per lb.

Ammonium Molybdate.—5s.—5s. 6d. per lb., according to quantity.

Argent. Nitras, Crystal.—1s. 1d. per oz.

Arsenic Iodide.—22s. 6d.—25s. per lb.

Benzonaphthol.—3s. 3d.—3s. 9d. per lb.

Berberine, Hydrochloride.—5s. 6d.—6s. per oz.; Sulphate, 5s. 6d.—6s. per oz.

Bismuth Salts.—Carbonate, 6s. 10d. per lb.; Citrate, 9s. 3d. per lb.; Nitrate (cryst.), 4s. 7d. per lb.; Oxide, 10s. 6d. per lb.; Salicylate, 7s. 7d. per lb.; Subchloride, 10s. 3d. per lb.; Subgallate, 7s. 3d. per lb.; Subnitrate, 5s. 11d. per lb. Above for cwt. lots. Extra and reduced prices for smaller and larger *quantities respectively. Liquor Bismuthi, P.B.,* in W. Qts.—1s. 1½d. per lb.; *6 W. Qts.—11d. per lb.; 12 W. Qts.—9½d. per lb.; 36 W. Qts.—9d.* per lb.

Borax, B.P.—Crystal, £24 10s. per ton. Powder, £25 per ton. For 1-ton lots and upwards, packed in 1-cwt. bags, carr. paid any station in Great Britain.

Bromides, B.P.—Ammonium.—1s. 10d. per lb. Potassium.—1s. 7d. per lb. Sodium.—1s. 9d. per lb. Prices for 1-cwt. lots.

Cadmium Iodide.—14s. 6d. per lb.

Calcium Hippurate.—26s.—30s. per lb.

Calcium Iodide.—20s. per lb.

Calcium Lactate, B.P.—1s. 2d.—1s. 4d. per lb., ac*ing to quantity.*

Camphor.—Refined flowers, 3s. 1d.—3s. 2d. pe Transparent tablets, 3s. 4d.—3s. 6d. per lb., ac ing to quantity; also special contract prices.

Chloroform.—2s. 3d.—2s. 8d. per lb.

Cinchophen.—11s. 6d.—12s. 6d. per lb.

Cocaine, Alkaloid and Citrate.—For export.—29s. —31s. 7d. per oz. Hydrochloride and Nit 27s. 1d.—28s. 11d. per oz.

Ephedrine hydrochloride.—5s. 6d.—6s. per oz.

Ergosterol.—2s. 6d. per gm.

Ethers.—S.G. 730, 1s. 1d.—1s. 2d. *per lb., accordin* quantity, and other prices according to spe gravity.

Hexamine.—2s. 4d.—2s. 6d. per lb., according *quantity.*

Hippuric Acid.—17s. 6d.—21s. 6d. per lb.

Hydrogen Peroxide (12 vols.).—1s. 4d. per gal., f makers' works, naked. B.P.—10 vols., 2s.—2s. per gal.; 20 vols., 3s. per gal.

Hypophosphites.—Calcium, 2s. 9d.—3s. 2d. per Potassium.—3s. 4d.—3s. 9d. per lb. Sodi 2s. 11d.—3s. 4d. per lb.

Iodine Resub., B.P.—14s. 8d.—18s. 9d. per lb.

Iodoform, B.P., Cryst., Precip. or Powder.—17s. 7 21s. 7d. per lb.

Iron *Ammon. Citrate.*—B.P.—1s. 9d. *per lb. for* 2 lots. Green, 2s. 5d. per lb. (list price).

Iron Iodide.—17s. 6d.—18s. per lb.

Iron Perchloride.—18s.—20s. per cwt., according *quantity.*

Iron Quinine Citrate, B.P.—9⅝d.—1s. 0½d. per according to quantity.

Lead Iodide.—14s.—15s. per lb.

Lithium Carbonate, B.P., 1914.—5s. 4d. per lb.

Lithium Chloride, Cryst.—8s. 3d. per lb.

Lithium Citrate.—5s. 3d. per lb. Powder.—5s. per lb.

Lithium Hippurate.—18s. 6d.—22s. 6d. per lb.

Lithium Iodide.—20s. 6d.—21s. 6d. per lb.

Magnesium Carbonate.—Light, 28s. per cwt.

Magnesium Oxide.—Light, 70s. per cwt.; Hea 1s. 8d. per lb.; in quantity lower.

Menthol.—A.B.R., recryst., B.P., *15s. per lb.* Synthetic, 8s. 6d.—12s. per lb. Synthetic detac crystals, 8s. 6d.—10s. 6d. per lb., according to qu tity; Liquid (95%), 8s. 6d. per lb.

Mercurials, B.P.—Red oxide crystals, 5s. 10d.—5s. 1 per lb.; Levig, 5s. 4d.—5s. 5d. per lb.; Corros sublimate, Lump, 4s.—4s. 1d. per lb.; Powd 3s. 8d.—3s. 9d. per lb.; White precip., Lur 4s. 9d.—4s. 10d. per lb.; Powder, 4s. 11d.—5s. lb.; Calomel, 4s. 9d.—4s. 10d. per lb. Yell Oxide, 5s. 2d.—5s. 3d. per lb.; Persulph., B.P. 4s. 11d.—5s. per lb.; Sulph. nig., 4s. 10d.—4s. 1 per lb. Special prices for larger quantities.

Mercury, Benzoate.—8s. 3d. per lb.; Cyanide, 12s. 7d 13s. 1d. per lb.; Oleate (5%), 1s. 11d.—2s. 2d. lb.; (10%), 2s. 9d.—3s. per lb.; (20%), 3s. 9d 4s. per lb. Protonitras, 6s. 9d. per lb.; Pro *sulphate, 7s. 3d. per lb.; Subsulphate flav., 7s.* per lb.

Methyl Salicylate.—1s. 4½d.—1s. 6½d. per lb.

Paraformaldehyde.—1s. 3d.—1s. 5d. per lb.

Paraldehyde.—1s. 4d.—1s. 10d. per lb.

Phenacetin.—4s.—4s. 6d. per lb.

Phenolphthalein.—4s. 5d.—5s. 8d. per lb.

Bitartrate.—99/100% (Cream of Tartar), s. per cwt., less $2\frac{1}{2}$%.

Citrate.—B.P., 1s. 7d. per lb. for 28-lb. lots.

ss. *Ferricyanide.—1s. $7\frac{1}{2}$d. per lb., in 125-lb. kegs.*

Iodide, B.P.—13s.—15s. 6d. per lb., according to quantity.

ss. Permanganate.—$8\frac{1}{4}$d. per lb. for 1-ton lots.

ss. Metabisulphite.—50s. per cwt. d/d London, kegs free.

ssium Hippurate.—26s.—30s. per lb.

ne Sulphate.—1s. 10d. per oz., for 100-oz. tins, tins free.

arin.—37s. 6d. per lb., and lower in quantity.

n.—15s.—16s. per lb., according to quantity.

um, B.P.—28s. per oz.

z powder (pulv.).—58s. 9d.—62s. 6d. per cwt.

r Nitrate.—1s. $3\frac{1}{4}$d. per *oz.* for quantity. Sticks, 2d. *per oz.* extra.

Barbitonum.—13s. 9d.—15s. per lb.

Benzoate, B.P.—1s. 7d. per lb., according to quantity.

Citrate, B.P.C., 1911.—1s. 4d. per lb. B.P.C., 1932, and U.S.P.—1s. 8d. per lb. for 28-lb. lots.

um Hippurate.—23s. 6d.—27s. 6d. per lb.

Hyposulphite.—Photographic, £15 per ton d/d consignee's station, in 1-cwt. kegs.

um Iodide, B.P.—14s.—17s. 1d. per lb.

Nitroprusside.—16s. per lb.

Potass. Tartrate (Rochelle Salt).—70s. per cwt. *net for 1-ton lots.* Crystals, 2s. 6d. per cwt. extra.

Salicylate.—Powder, 2s.—2s. 8d. per lb. Crystal, 2s. 1d.—2s. 9d. per lb.

Sulphide.—Pure recryst., 10d.—1s. 2d. per lb.

Sulphide anhydrous.—£23—£25 per ton, according to quantity, d/d U.K.

ntium Iodide.—17s. 6d. per lb.

ar Emetic B.P.—3s. 9d.—4s. 6d. per lb.

ne hydrate.—1s. 2d.—1s. 5d. per lb.

nol, Puriss.—5s. 9d.—6s. 6d. per lb., according to quantity. Natural.—12s. per lb.

Iodide.—21s.—22s. per lb.

Stearate.—1s. 4d.—1s. 6d. per lb.

PERFUMERY CHEMICALS

ophenone.—7s. per lb.

pine (*ex Anethole*).—8s. per lb.

Acetate.—2s. 3d. per lb. Amyl Butyrate.—4s. per lb. Amyl Cinnamic Aldehyde.—8s. 3d. per lb. Amyl Salicylate.—2s. 9d. per lb. Anethol, 21/22° C. 4s. 9d. per lb.

aldehyde free from Chlorine.—2s. 9d. per lb.

yl Acetate from Chlorine-free Benzyl Alcohol.—2s. per lb. Benzyl Alcohol free from Chlorine.—2s. per lb. Benzyl Benzoate, 2s. 3d. per lb.

amic Aldehyde.—Natural, 12s. 3d. per lb.

nellol.—6s. 6d. per lb.

—6s. 6d. per lb.

marin.—15s. per lb.

Cinnamate.—8s. 6d. per lb.

Phthalate.—2s. 6d. per lb.

nol.—7s. 3d. per lb. Geraniol (Palmarosa).—7s. per lb. Geraniol.—6s. 6d.—11s. per lb. Heliotropine.—6s. per lb. Iso Eugenol.—8s. 6d. per lb. Linalol.—(*ex Bois de Rose*) 6s. 3d. per lb.—(*ex Shui Oil*) 5s. 9d. per lb. Linalyl Acetate.—(*ex Bois de Rose*) 8s. 3d. per lb.—(*ex Shui Oil*) 7s. per lb.

yl Anthranilate.—9s. per lb.

yl Benzoate.—4s. 6d. per lb.

Musk Ketone.—33s. per lb.

Musk Xylol.—8s. per lb.

Nerolin.—5s. per lb.

Phenyl Ethyl Acetate.—10s. per lb.

Phenyl Ethyl Alcohol.—8s. 6d. per lb.

Rhodinol.—60s. per lb. Safrol.—1s. 6d. per lb. Terpineol.—2s. per lb. Vanillin (*ex Clove Oil*).—16s.—18s. per lb.—(*ex Guaiacol*)—14s. 3d.—16s. 3d. per lb.

ESSENTIAL OILS

Almond.—Foreign S.P.A., 9s. per lb. Anise.—2s. 1d. per lb. *Araucaria*, 8s. 6d. per lb.—Bergamot.—6s. 6d. per lb. Bourbon Geranium.—25s. 3d. per lb.

Camphor.—Brown, 80s. per cwt.—White, 85s. per cwt. Cananga, Java, 10s. per lb. Cinnamon Oil.—3s. 6d. per lb. Cassia, 80/85%, 4s. 6d. per lb.

Citronella Oil.—Java, 2s. 9d. per lb. Ceylon, 2s. 3d. per lb. Clove.—90/92% English, 4s. 9d. per lb.

Eucalyptus, Australian B.P., 70/75%.—1s. per lb. *Huon Pine* (*Methyleugenol*, 95%), 16s. *per gal.* Lavender.—Mont Blanc, 38/40%.—10s. per lb. Lemon.—4s. 3d. per lb. Lemongrass.—3s. per lb. Orange, Sweet.—6s. per lb. Otto of Rose.—Anatolian, 37s. 6d. per oz.; Bulgarian, 55s. per oz. Palma Rosa, 9s. per lb.

Peppermint.—Japanese, 6s 6d. per lb. Wayne County, 14s. per lb. *Petitgrain.*—5s. 9d. per lb.

Sandalwood, Mysore—30s. per lb. 90/92%, 20s. per lb. Australian, B.P. and French Codex, 92/95%, 15s. 6d. per lb.

INTERMEDIATES

Items marked thus * d/d buyers' works.

*Acid, Benzoic, 1914 B.P. *ex Toluol.*—1s. $9\frac{1}{2}$d. per lb. in casks.

*Acid Gamma.—Spot, 4s. per lb., 100%.

*Acid H.—Spot, 2s. $4\frac{1}{2}$d. per lb., 100%.

*Acid Neville and Winther.—Spot, 3s. per lb., 100%.

*Acid Sulphanilic, 8d. per lb.

*Aniline Oil, spot, 8d. per lb., drums extra.

*Aniline Salts, spot, 8d. per lb., casks free.

*Benzaldehyde, spot, 1s. 8d. per lb., packages extra.

*Benzidine Base.—Spot, 2s. 5d. per lb., 100%.

o-Cresol 30/31° C.—£2 6s. 5d. *per cwt. in 1-ton lots.*

m-Cresol 98/100%.—2s. 3d. per lb., in ton lots.

p-Cresol 34.5° C.—1s. 9d. per lb., in ton lots.

Dichloraniline.—2s. 3d. per lb.

*Dimethylaniline.—Spot, 1s. 6d. per lb., packages extra.

Dinitrobenzene.—8d. per lb.

Dinitrotoluene 48/50° C.—8d. per lb. 66/68° C.—$8\frac{3}{4}$d. per lb.

*Diphenylamine.—Spot, 2s. per lb.

*α-Naphthol.—Spot, 2s. 4d. per lb.

*β-Naphthol.—Spot, £78 15s. per ton, in paper bags; £79 15s. per ton in casks, in 1-ton lots.

*α-Naphthylamine.—Spot, $11\frac{1}{2}$d. per lb.

*β-Naphthylamine.—Spot, 2s. 9d. per lb.

o-Nitraniline.—5s. 10d. per lb.

**m*-Nitraniline.—2s. 7d. per lb.

**p*-Nitraniline.—Spot, 1s. 8d.—2s. 1d. per lb.

*Nitrobenzene.—Spot, $4\frac{1}{2}$d. per lb., 5-cwt. lots, drums extra.

Nitronaphthalene.—9d. per lb.

*Sodium Naphthionate.—Spot, 1s. 9d. per lb., 100%.

**p*-Toluidine.—Spot, 1s. 11d. per lb.

**o*-Toluidine.—Spot, $9\frac{1}{2}$d. per lb., drums extra.

m-Xylidine acetate, 3s. 4d. per lb., 100%.

PATENT LIST

The following is a list of complete specifications of chemical interest which are open for inspection under Section 91 (4) (*a*) of the Patent Acts. Printed copies are not available, but photographic copies may be obtained at a charge of 8d. per page (minimum 1s.) from the Patent Office, Chancery Lane, W.C.2.

I. 35,482 (1932). Robison. Continuous rotary filters.

35,772 (1932). Tecalemit, Ltd. Apparatus for mixing liquids or liquids and gases.

II. 31,693–4 (1932). Universal Oil Products Co. Treatment of motor fuel.

34,199—200 (1932). Bataatsche Petroleum Maats. Conversion of unsaturated hydrocarbons into high grade products, such as non-oxidizing lubricating oils.

35,324 (1932). Mathieu. Production of gaseous fuel mixtures from liquid fuels.

35,473 (1932). Kogag Koksofenbau u. Gasverwertung A.-G. Coke ovens.

35,951 (1932). Still. Cracking of hydrocarbons.

III. 12,579 (1932). Soc. Française de Catalyse Généralisée. Production of ethylene oxide, particularly for the preparation of ethylene glycol and of its derivatives.

33,410—11 (1932). Henkel & Co. Manufacture of high-molecular sulphur compounds.

34,038 (1932). Henkel & Co. Manufacture of esters and thio esters substituted in the acid residue.

35,701 (1932). I. G. Farbenind. Manufacture of aqueous solution of aminoacridine salts.

IV. 35,446 (1932). Soc. Chem. Ind. in Basle. Manufacture of azo dyestuffs.

35,766 (1932). I. G. Farbenind. Manufacture of azo dyestuffs.

V. 34,985 (1932). Soc. Chem. Ind. in Basle. *See* VI.

35,625 (1932). Bemberg A.-G. Making skins from cellulose solutions.

VI. *18,357 (1932) Erba Fabr. Chem. Prod. Treatment* of textiles, paper, leather, skins, etc.

34,985 (1932). Soc. Chem. Ind. in Basle. Dyeing or printing paper or paper pulp.

VII. 35,942–5 (1932). Metallges. Production of sulphuric acid.

IX. 34,428 (1932) Jeantet. Production of regenerated wood from wood powders.

X. 31,192 (1932). Krupp A.-G. Armour plate.

35,432 (1932). Schiffler. Steel alloys

35,676 (1932). Grasselli Chem. Co. Cleaning and pickling of metals

35,692 (1932). Allied Process Corp. Making heat-treated white cast iron.

XIII. 36,018—9 (1932). Kreidl. Production of artificial resins.

XV. 18,357 (1932). Erba Fabr. Chem. Prod. *See* VI.

35,677 (1932). Grasselli Chem. Co. Manufacture of adhesive and film-forming compositions.

35,735 (1932). Votteler's Nachfolger. Production of artificial leather.

XX. 35,701 (1932). I. G. Farbenind. *See* III.

35,702 (1932). I. G. Farbenind. Manufacture of stable solutions of anæsthetic substances.

13,836—9 (1933). Parke, Davis & Co. Extracts obtainable from mammalian suprarenal glands.

XXI. 35,568 (1932). I. G. Farbenind. Photographic plates or films.

35,586 (1932). I. G. Farbenind. Sensitizing photographic silver halide emulsions.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development a Intelligence), 35, Old Queen Street, London, S.W.1, l received the following inquiries for British goo British firms may obtain further information by apply to the Department and stating the specific numl *Argentina :* Hardware, paint, and varnish (925). *Austr* Steel (908) ; Tin and other non-ferrous metals (90 Heavy and industrial chemicals (910). *Belgiu* Pharmaceutical products (912). *British India :* Pho graphic materials, soap (882). *Canada :* Alum (8 *Eastern Morocco and Algeria :* Metal (922). *Finla* Hardware etc. (913). *Holland :* Pharmaceutical chemical works (917). *Poland :* Alloys (920).

Precipitated Chalk

The valuable physical properties of precipitated ch are of importance in many industries, notably th concerned with paper and printing, pharmacy, fo stuffs, and plastics. A concise reference book concer with standardization and testing is therefore of ma interest to many manufacturers, and a book of t sort, "Precipitated Chalk," has now been published John & E. Sturge, Ltd., 15, Wheeler's Lane, Birmingh It is priced at 2s. 6d., but responsible executives manufacturing chemists and other large users of ch may obtain copies free on application to the publish

The most important part of the book is that on ch testing. John & E. Sturge, Ltd., has more t 60 years' experience of supplying chalk, so that tests described are the result of very adequate crit examination, and have been selected on the grou of ease of manipulation combined with accuracy. tests are divided into the determination of phys properties and the determination of chemical pur and in both sections many little practical details given which are obviously the result of much laborat experience.

Other parts of the book deal in a simple manner w the history and geology of chalk, the properties precipitated chalk, and its uses in industry. M excellent illustrations are included, and the many mi photographs are, with two exceptions, of the s magnification, namely, × 500, and a transparent bo mark is provided with a printed scale of lines re senting 1/1000 in. intervals on these micro-photogra This should be of considerable use in the microsco examination of chalk, and the procedure is one wh might be adopted with advantage in many text boo

Change of Address

Messrs. Riley, Harbord and Law, consulting met urgists and chemists, have removed their premises Parliament Mansions, Orchard Street, Victoria Str London, S.W.1. The offices, chemical laboratories, cement and concrete testing laboratories are now hou in one building. There is no change in the teleph numbers, which remain Victoria 2661/2.

Key Industry Duty

The Treasury has made an Order under Section 10 of the Finance Act, 1926, exempting ethyl cellulose methyl cellulose from key industry duty from J 7, 1933 to December 31, 1933. The Order will sho be published by H.M. Stationery Office.